The Dissertation Committee for Crystal Marie Lantrip Certifies that this is the approved version of the following dissertation:

Neural correlates of emotion regulation: An fMRI Study of Big Picture Reappraisal

Committee:

Stephanie Rude, Co-Supervisor

Douglas G. Allen, Co-Supervisor

Nancy Nussbaum

David Schnyer

Christopher McCarthy

Neural correlates of emotion regulation: An fMRI Study of Big Picture Reappraisal

by

Crystal Marie Lantrip, B.S.Psy.; M.A.

Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas at Austin

August 2013

Acknowledgements

I would like to express my gratitude and appreciation to Stephanie Rude. You have shared your passion for research and provided generous support and encouragement in all aspects of this journey through graduate school. Your enthusiasm for scientific inquiry in particular has been contagious and I feel fortunate to have been part of your lab. I am especially thankful for all the time you have invested into my professional development. You have helped funnel my energies into pragmatic directions, been my fan when things are going well, and stood beside me when problems have arisen over the past five years and I am thankful.

Many thanks also to Greg Allen and David Schnyer for fostering my interest in brain-behavior relationships and skills in neuroimaging. This research interest has also shaped my clinical interests as well as future plans and career path and I have been so fortunate to have worked with you both. Having your support has enabled me to pursue this exciting facet of the field of psychology.

Special thanks to Nancy Nussbaum for your unflagging support and encouragement in my efforts to pursue clinical work in neuropsychology. I have learned a great deal from you over the years and was thrilled when you agreed to be part of my dissertation committee. I appreciate the commitment you have to your students. You encourage the pursuit of knowledge within clinical work and modeled how to apply research to the practice of neuropsychology. You are a great role model.

Also thank you to Chris McCarthy for your time and support on this project and throughout graduate school. Your dedication to teaching and to students in the counseling program is appreciated. You have played an important role in fostering my professional development and I am appreciative of your helpfulness and enthusiasm.

Importantly, I would like to thank my biggest source of support in this journey, Troy Keith, for his patience, encouragement, wisdom, and strength. You have sacrificed much to make his possible, and I am grateful.

Neural correlates of emotion regulation: An fMRI Study of Big Picture Reappraisal

Crystal Marie Lantrip, Ph.D.
The University of Texas at Austin, 2013

Co-Supervisors: Stephanie Rude, Douglas G. Allen

Cognitive emotion regulation strategies can be used to counter the negative effects of life stress. In neuroimaging paradigms, many different types of reappraisal strategies have been used to promote cognitive coping with impersonal, emotion-evoking stimuli, but limited research has been done utilizing specific reappraisal strategies with real-life events. Big picture reappraisal is a specific emotion regulation strategy that offers a way of managing distress aiming to promote acceptance and cognitive coping. Big picture reappraisal instructions (experimental condition) were compared to distraction and rumination instructions (control conditions) resulting in activation in areas associated with cognitive control (orbital frontal cortex, superior parietal lobe, cerebellum lobule VI). Mood ratings collected after each of several condition prompts were significantly more positive in the distraction compared to the big picture reappraisal condition during the first third of the induction, but as the task progressed the effectiveness of distraction declined considerably. There were no significant condition differences in mood during the second and third segments of the induction.

TABLE OF CONTENTS

CHAPTER ONE

Article Style Document

Introduction

Cognitive coping strategies are utilized to help individuals change how they think about distressing life events and associated feelings (Beck, 1976; Conway, Csank, Holm, & Blake, 2000; Gross, 2002), and are often associated with positive outcomes (e.g. Aldao, Nolen-Hoeksema, & Schweizer, 2010; Rude, Mazzetti, Pal, & Stauble, 2011; Sutherland & Bryant, 2007). Understanding the effects of cognitive interventions in the brain is an important next step for understanding how emotional regulation occurs.

A primary way that emotion regulation has been studied in fMRI paradigms is through tasks in which participants are asked to reappraise negative emotion-evoking stimuli. Reappraisal has been defined as changing thoughts about a situation in order to decrease the emotional impact and behavioral expression of the emotion (Gross, 2002). Studies have shown that self reports of frequent use of reappraisal is related to greater experience and expression of positive mood, less experience and expression of negative mood, and fewer symptoms of depression (Gross and John, 2003; John and Gross, 2004). Poor reappraisal ability has also been associated with cognitive problems. For example, in a study by Joorman and Gotlib (2010), never-depressed, formerly-depressed, and currently depressed participants who had difficulty with reappraisal demonstrated difficulty with inhibition of negative material. Along these lines, ability to downregulate emotions, as measured by reduction in body movement and emotional facial behavior, has been positively correlated with verbal fluency, a common measure of executive functioning (Gyurak et al., 2009). Trait tendency to reappraise has also been found to correlate with the rise and fall of prefrontal and/or amygdala activity (Ochsner & Gross, 2008).

In fMRI paradigms, there have been a variety of different instructions to help participants reappraise. Participants are sometimes instructed simply to "reappraise." They are also asked to distance (e.g. act as though you are a third-party observer) as well as to be more analytical (e.g. analyze a photo) or simply decrease negative affect. Some of these instructions prove useful for reappraisal of impersonal emotion-eliciting pictures or videos, but are presumably much less useful for reconsidering emotions regarding *actual* distressing events. In fact, overly-simplistic reappraisal instructions, such as the above examples, would often be counterproductive long-term. For instance, acting as though you are a third party observer when experiencing a social rejection could promote the use of avoidance and might even lead to socially dysfunctional behavior.

Most fMRI studies are defining reappraisal in these ways that seem problematic when applied to one's life. To date, relatively little is known about neural activity during fMRI tasks when participants are thinking about a real-world experience. In a recent review by Ochsner, Silvers, and Buhle (2012) outlining different types of stimuli used to evoke emotion in functional neuroimaging emotion regulation experiments, only one study out of 43 utilized autobiographical memories to induce emotion while most used standard pictures or videos (Kross, Davidson, Weber, & Ochsner, 2009) . This gap in the literature is important to address. Exploring how reappraisal of everyday distress could alter neural activity allows for a deeper understanding of mechanisms involved in day to day emotion regulation.

Big picture reappraisal is a specific type of reappraisal that promotes awareness of the broader contexts in which *actual* adversity and distress occur (Rude, 2011) and has been found to reduce rumination and depression symptoms compared to thinking about abstract reasons for, or implications of distress in a college population (Rude, Mazzetti, Pal, &Stauble, 2011). Briefly, big picture appraisal involves considering a distressing event or situation while maintaining awareness of how the event and/or reactions to it fit into an extended time perspective (e.g., distress fluctuates and dissipates over time), the broader context of one's life (e.g. awareness of wanted and unwanted experiences), and/or the broad human context (e.g. all people deal with adversity and distress and goals are fundamentally similar) (Rude, 2011). This reappraisal strategy has potential to improve cognition in a brief and effective manner utilizing well-researched concepts from mindfulness.

When considering other ways to regulate emotions about distressing life events; rumination and distraction are strategies that have been extensively studied. Rumination is a way of responding to distress that involves repetitively and passively focusing on symptoms of distress and on the possible causes and consequences of these symptoms (Nolen-Hoeksema, 1991). Rumination has been shown to make significant contributions to maintaining depression, particularly in women, and is related to poor mental health outcomes (Nolen-Hoeksema, 1991; 1996; Watkins & Brown, 2002). Further, rumination has been correlated with many cognitive problems including difficulty with concentration, memory, inhibition, cognitive flexibility, and problem solving (Davis & Nolen-Hoeksema, 2000; Hertel & Rude, 1991; Hertel & Gerstle, 2003; Hong 2007). Nolen-Hoeksema posited that theses cognitive problems exist because rumination detracts from cognitive resources (Davis & Nolen-Hoeksema, 2000). On the other hand, a cognitive process actively involved in rumination is self-referential thinking. Research using fMRI has found that high levels of trait rumination are positively correlated with self-referential thinking as evidenced by medial prefrontal cortex (mPFC) activation when participants are instructed to increase negative affect (Ray et al., 2005). In addition, ruminative self-focus was positively associated with enhanced recruitment of mPFC in a depressed population (Cooney, Joormann, Eugene, Dennis, & Gotlib, 2010). Further, the detection and encoding of negative emotional information and mood states in ruminative thought processes has been positively associated with amygdala activation (Anderson & Phelps, 2001; Hamann, Monarch, & Goldstein, 2000; Siegle, Steinhauer, Thase, Stenger, & Carter, 2002; Ray et al., 2005).

Distraction has proven helpful to counter the effects of rumination in the short-term (Morrow & Nolen-Hoeksema, 1990), but other research has shown that it was less helpful as a long-term strategy (Nolen-Hoeksema,Wisco, & Lyubomirsky, 2008). Distraction involves taking attention away from distressing thoughts or feelings and re-focusing on positive or neutral information. Unlike rumination, distraction is sometimes found to have positive effects. Experimental research has demonstrated that when dysphoric participants are distracted from negative thoughts, this can lead to more positive appraisals of events, better problem solving, and less distress (Nolen-Hoeksema,Wisco, & Lyubomirsky, 2008). Reduced distress often leads to diminished fear and negativity, as evidenced by decreased amygdala activation in neuroimaging research (Anderson & Phelps, 2001).

The purpose of the current study was to explore the neural correlates of big picture reappraisal, as compared to rumination and distraction, with regard to a real-life distressing event. The study examined the effects of prompting participants to reflect upon a recent social rejection on neural activity and mood under three conditions, Rumination (e.g. Think about why this happened to you), Big Picture Reappraisal (e.g. Think about how all moods come and go with time), and Distraction (e.g. Think about the shape of a stop sign). Rumination and distraction prompts were borrowed from Nolen-Hoeksema (S. Nolen-Hoeksema, personal communication, March 23, 2009). Reappraisal prompts were based on work regarding big picture reappraisal, a specific type of reappraisal discussed by Rude.

Overall, it was expected that big picture reappraisal would involve increased cognitive control consistent with the theory and research demonstrating that reappraisal requires recruitment of regions involved in cognitive control, specifically the dorsal lateral prefrontal cortex (dlPFC), posterior parietal lobe, mPFC, and cerebellum, to cognitively process emotions (Gross, 1998; Ochsner, Silvers, & Buhle, 2012). It was hypothesized that cognitive control would be involved to a greater extent in big picture reappraisal compared to rumination and distraction and lead to greater activation of these regions. In addition, it was expected that big picture reappraisal would involve reduced negative emotionality and arousal consistent with the theory (Gross, 1998) and research demonstrating that reappraisal attenuates negative arousal compared to rumination (Ochsner, Silvers, & Buhle, 2012). Rumination compared to distraction and big picture reappraisal was hypothesized to result in greater negative arousal as measured by amygdala activation. Overall, mood was hypothesized to improve in both the big picture reappraisal and distraction conditions compared to rumination.

Method

Sample. Female, right-handed community members from the Central Texas area (*N*=28; mean age = 25.83, standard deviation = 9.28; Caucasian = 48%, Asian descent = 24%, Hispanic/Latina = 20%, African American = 8%) were recruited from online advertisements, local media, and posted flyers. Flyers stated that participants needed to have a recent social rejection experience in order to be study-eligible and received $30 for participation. Prior to study-entry, they underwent a phone screening which was utilized to gather information regarding demographics, MRI safety and a recent social rejection. Specifically, in this phone screening participants were asked about a social rejection experience in the past six months that still bothered them and answered questions regarding their feelings about the rejection experience. Participants were excluded from the study if they reported having a current DSM-IV-TR diagnosis by a mental health professional, were currently in therapy, or taking psychiatric medications. The data from three runs (two participants) of the fMRI task were not useable due to unexpected problems with the scanner and one person discontinued participation after becoming claustrophobic in the scanner making the analysis total N=25.

Design. Each run maintained the same order and timing of stimuli. The run was initiated with three prompts guiding the participant to think about the rejection experience. These prompts appeared at the onset of the run and were not repeated in the run sequence. These were followed by a prompt to rate mood and three condition-specific prompts (Big Picture Reappraisal, Distraction, or Rumination). Participants were then asked to rate mood again, count backwards (active control), rate their mood, then look at a visual fixation crosshairs (inactive control). This sequence of control and experimental stimuli repeated, occurring a total of three times per run. Each participant completed two runs. An example of part of a Big Picture Reappraisal run can be seen in Figure 1.1. A complete list of condition-specific prompts used in the experiment is reported in Appendix A.

Each participant completed two runs. Each run included a full set of nine prompts for one of the three conditions. Each participant only completed two of the three possible runs (Big

Picture Reappraisal (B), Distraction (D), Rumination (R); BR=4, BD=4, RB=5, RD=2, DB=4, DR=2) through random assignment. Participants rested for approximately one minute between runs. Each run took approximately seven minutes. The runs were programmed using DMDX Software (Forster and Forster, 2003). The ideal number of participants needed for this design at a power level of .95 and an alpha of .05 was determined with a G*Power (Erdfelder, Faul, & Buchner, 1996) analysis. This analysis suggested a sample size of 39. Given that the number of participants able to complete the study was lower than this ideal number (N=25), it was likely more difficult to detect statistically significant differences in this sample.

Figure 1.1

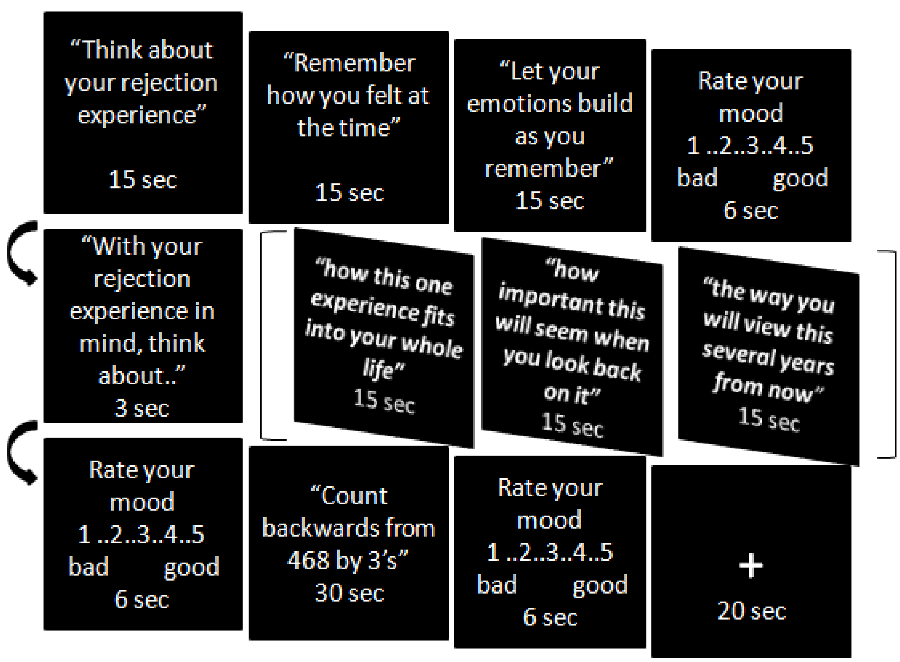


Figure 1.1 Timeline of the first third of one run. The initial 4 slides only appear once in the sequence. The slide stating "With your rejection experience in mind, think about…." initiates the sequence that repeats three times within the run. The stimuli in the three tilted boxes in brackets are experimental stimuli. Nine different condition-specific statements are included in each run. The counting and visual fixation "+" slides are controls.

Imaging assessment and fMRI data acquisition. Scanning was performed on a whole body 3T GE MRI scanner with an 8 channel phase array head coil. The scanning protocol involved a collection of a localizer, shimming routines, a T1-weighted high-resolution structural scan, and then the functional MRI data collection. The structural scan used was one 3D SPGR volume acquisition, with 1.4 mm thick axial slices for a total of 134 slices (Flip=10 degrees, TR=9.7 ms, TE=4 ms, TI=20 ms, TD=0 ms, FOV=25 cm, Matrix=256X256, NEX=1).

Functional MRI data were acquired while participants completed the emotion regulation task. MR images were collected utilizing whole head coverage with slice orientation to reduce artifact (approx 20 degrees off the AC-PC plane, TR = 2 sec., TE = 23 msec., 31 axial slices oriented for best whole head coverage, acquisition voxel size = 3.125 X 3.125 X 3 mm with a .3 mm inter-slice gap). A multiecho GRAPPA parallel imaging EPI sequence was used to optimize BOLD signal in regions susceptible to artifact. Stimuli were viewed through a back projection screen and a mirror mounted on the top of the head coil. Responses were collected with 5 button MR compatible optical transmission devices that were held in one hand. Head motion was minimized with foam inserts.

fMRI analysis. Imaging data were analyzed in a multistage process using FEAT (fMRI Expert Analysis Tool; FMRIB, Oxford, United Kingdom, http://www.fmrib.ox.ac.uk/fsl). Preprocessing was conducted along standard procedures in FEAT. Raw, unprocessed data were reviewed for quality. At the first level, statistical analysis was carried out using a general linear model approach. The conditions were big picture reappraisal, distraction, and rumination. There were also active (counting) and inactive (visual fixation) control conditions. Contrast images were then used in fixed-effects group analyses, calculating statistically significant increases or decreases in blood oxygenation level-dependent (BOLD) signal in response to the stimuli. Group images were thresholded using cluster detection statistics, with a height threshold of $z > 2.3$ and a cluster probability of $p < .05$, corrected for whole-brain multiple comparisons using Gaussian Random Field Theory (GRFT). Given the novel nature of the paradigm and conditions, activation of a hypothesized region (amygdala) at a more liberal threshold ($p < .01$, uncorrected) was explored to show some interesting, although preliminary, trends in activation.

Procedure

Prior to participating in the study, participants were screened over the phone to ensure that they were eligible to safely participate and met study criteria. All the remaining procedures occurred at the appointment at the Imaging Research Center at The University of Texas at Austin. Participants gave their informed consent and filled out standard MRI safety questionnaires. Then, participants completed a practice task on a laptop via a Powerpoint presentation outside of the scanner. This task was similar to the emotion regulation task completed in the scanner but did not focus on their rejection experience or on reappraisal. Instead, participants were asked to think about aspects of their personal experience while taking the practice task (e.g. focus on the physical sensations you feel in your body). The participants then answered questions relevant to their rejection experience and wrote about their rejection experience for 15-20 minutes so that the experience was salient when they began the fMRI task. During the scan, structural MRI data were acquired during the initial 5-10 minutes, then participants completed a task consisting of two 7-minute runs during which they also rated mood (10 mood ratings per run). After the scan, participants were debriefed and paid $30 for participation.

Results

Mood Data.

Overview: As described above, there were three conditions: Big Picture Reappraisal, Rumination, and Distraction. Each run was comprised of one condition (see Figure 1.2). The dependent variable was mood. Mood ratings were on a scale of 1-5 (1=negative mood, 5=positive mood). Mood was rated 10 times per run. Mood rating 1 was prior to condition-specific prompts, mood ratings 2-4 were after the first set of three condition-specific prompts, mood ratings 5-7 were after the second set of three condition-specific prompts, and mood ratings 8-10 were after the third set of three condition-specific prompts. There were also active (counting backwards) and inactive (visual fixation) controls presented between the mood ratings (see Figure 1.2). Each group of three mood ratings was averaged to form a mood rating cluster at times 1, 2, and 3. After checking to ensure that there were not effects for order of run, mood ratings for the analysis were combined from runs 1 and 2 from each condition (Big Picture Reappraisal, Distraction, or Rumination). There were some missing mood ratings in the dataset and in these cases; the average of the two mood ratings in the cluster was used to interpolate the third mood rating. In the case that there were not at least two mood ratings in the cluster, the data was not used. Each person rated their mood 20 times total throughout the two runs. The initial mood ratings in both runs were included as covariates, accounting for mood immediately following rejection experience reminder prompts.

Figure 1.2.

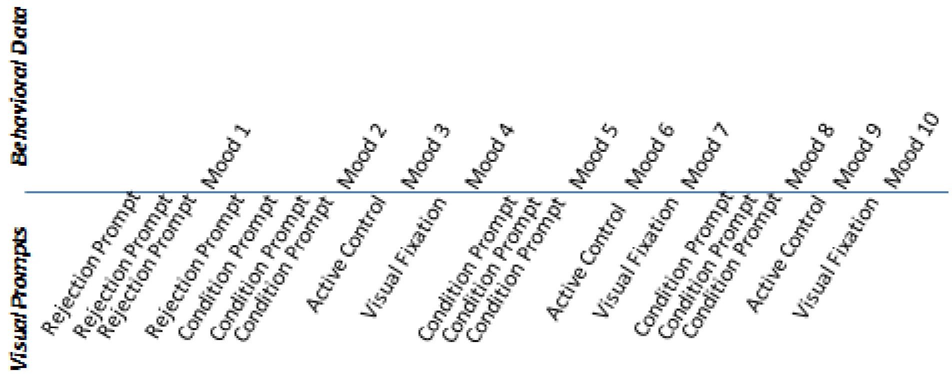


Figure 1.2. Order of stimuli in Run 1 (approximately 7 minutes in duration). The top portion of the timeline is the behavioral, or mood data (participants rated mood on a scale of 1-5 on a 5-button response box inside the scanner during the task). The bottom portion of the timeline is the order of visual stimuli to which the participants did not behaviorally respond. (Rejection Prompts= reminder statements about the rejection experience, Condition Prompts=Condition-Specific Stimuli (Big Picture Reappraisal, Rumination, or Distraction), Active Control=Counting, Visual Fixation=Inactive Control). Stimuli in Run 2 were presented in the same order.

ANCOVA Analyses. When contrasting Big Picture Reappraisal, Rumination, and Distraction during both runs 1 and 2 combined there was a significant mood by treatment interaction (Mood Cluster Time Point x Condition [$F(2,32)=3.955$; $p=.029$] (see Figure 1.3). To decompose this interaction, simple effects at each of the three mood cluster time points were tested by running one-way analyses of covariance (ANCOVAs) for the mood cluster at each time point, using Mood Rating 1 as the covariate, and following up significant effects with post hoc contrasts. For the first mood cluster, the one-way ANCOVA omnibus approached significance [$F(2,34)=2.551$; $p=.093$] and was followed up. For this mood cluster, Distraction yielded significantly better mood than Big Picture Reappraisal [$F(1,25)=5.190$; $p=.032$] and trended towards significantly better mood than Rumination [[$F(1,20)=1.851$; $p=.189$]. Significant differences were not observed for mood clusters at time points 2 or 3 ($ps > .34$).

Figure 1.3.

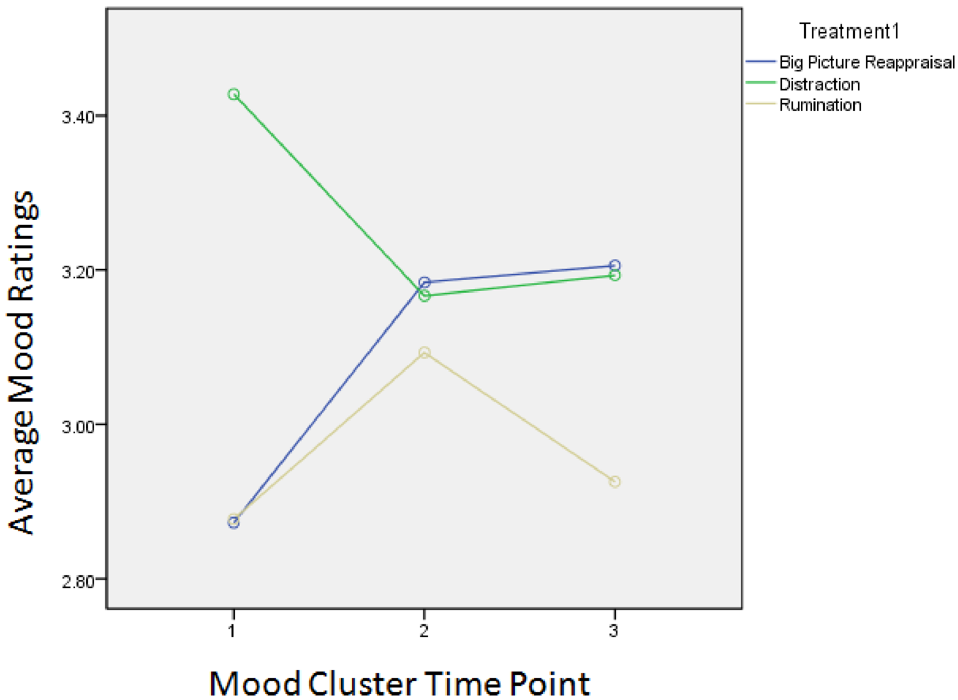


Figure 1.3. Graph of Repeated Measures ANCOVA with Mood Clusters at Times 1,2, and 3. When contrasting Big Picture Reappraisal, Rumination, and Distraction during both Runs 1 and 2, there was a significant mood by treatment interaction (Mood Cluster Time Point x Condition [$F(2,32)=3.955$; $p=.029$].

Brain Imaging Findings.

Big Picture Reappraisal versus Rumination

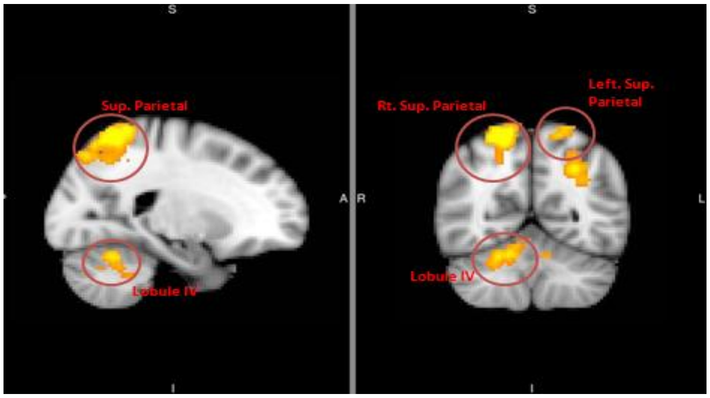
Brain regions implicated in cognitive control in the big picture reappraisal condition compared to rumination were investigated (see Figure 1.4). It was hypothesized that when big picture reappraisal was compared to rumination, this contrast would result in greater dlPFC, posterior parietal, and cerebellar activation. This contrast yielded significant activation in bilateral superior parietal cortex as well as right cerebellum lobule VI (see Table 1.1). The contrast involving dorsal lateral prefrontal cortex activation was not significant. It was hypothesized that the amygdala, implicated in negative emotional arousal, would be activated when rumination was compared to big picture reappraisal. When rumination was used as the experimental task and big picture reappraisal was used as the control, there was not significant activation in any brain region.

Big Picture Reappraisal versus Distraction

Big picture reappraisal compared to distraction was hypothesized to show increased activation in the mPFC (see Figure 1.5). This hypothesis was not supported; however, significant activation in the left OFC, or Brodmann's area (BA) 11 was found (see Table 1.1). When comparing distraction to big picture reappraisal, there was significant activation in the left prefrontal cortex that included part of Broca's area (BA 45), dlPFC (BA 46), and left inferior parietal lobe. These regions are associated with selective attention and working memory, as well as language processing. Overall, it was evident that big picture reappraisal significantly differed from rumination and distraction in some hypothesized ways but there were also some findings related to cognitive control when distraction was compared to big picture reappraisal.

Condition (Big Picture Reappraisal, Rumination, or Distraction)>Active Control

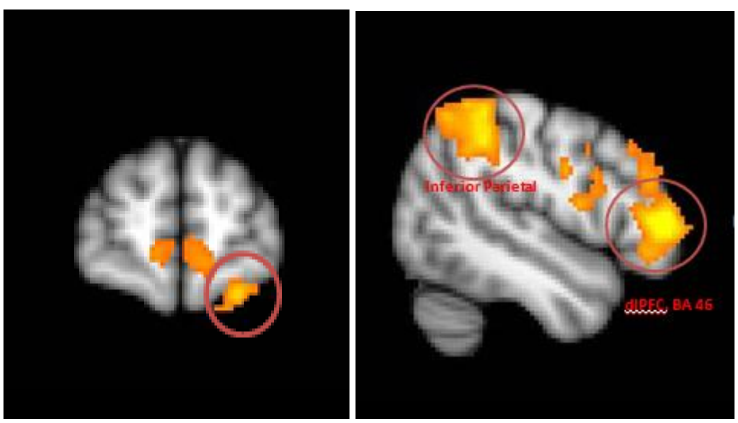
Brain regions implicated in negative emotional arousal in the distraction, rumination, and big picture reappraisal conditions were investigated. It was hypothesized that rumination and distraction would result in greater amygdala activation than big picture reappraisal. When the rumination (experimental) condition was compared to an active control, amygdala activation was not evidenced at the strict, cluster-corrected $p<.05$ level. When the distraction (experimental) condition was compared to an active control, amygdala activation was also not evidenced at the cluster-corrected $p<.05$ level. In addition, when the big picture reappraisal (experimental) condition was compared to an active control, amygdala activation was not evidenced at the cluster-corrected $p<.05$ level. Upon further analysis at a more liberal, cluster-uncorrected, $p<.01$ threshold (see Table 1.1), amygdala activation was evidenced when rumination was compared to an active control and when distraction was compared to the active control. When big picture reappraisal was compared to active control, there was not significant amygdala activation at the more liberal threshold. These results, obtained with cluster-uncorrected data analysis, indicated important trends in the data for potential future investigation.



<u>BPR>Rumination</u>

Activation: Right Cerebellum Lobule VI, Left Superior Parietal Lobe, Sagittal View (Left) and Coronal View (Right) (Clusters 2, 3, & 4 in Table)

Figure 1.4. Big Picture Reappraisal (BPR)>Rumination (Rum); there was significant activation in Right Lobule VI of the Cerebellum and Right Superior Parietal activation. Rum>BPR did not yield significant activation.



<u>BPR versus Distraction</u>

BPR>Dist, Left BA11(Cluster 1; Left Image)
Dist>BPR, Inferior Parietal and Left BA 45,46 (Cluster 5,6; Right Image)

Figure 1.5. BPR>Distraction (Dist); there was significant activation in left BA 11 (OFC) and significant activation in left BA 45,46 (Broca's area, DLPFC) and inferior parietal lobe in the Dist>BPR contrast.

Table 1.1.

Cluster	Brodmann's Area	X	Y	Z	Z	L/R	K	Corrected p<.05
BPR>Distract								
Cluster 1	**BA11**	-22	+60	-20	4.5	L	1310	
Orbital Frontal Cortex								
Medial Prefrontal Cortex								
BPR>Rum								
Cluster 2		-38	-36	+64	6.25	L	4407	
Postcentral Gyrus								
Superior Parietal Lobule								
Cluster 3		+24	-54	+62	5.88	R	1336	
Superior Parietal Lobule								
Superior Lateral Occipital Cortex								
Cluster 4		+22	-58	-24	4.09	R	1133	
Cerebellum Lobule VI								
Cerebellum Lobule V								
Distract>BPR								
Cluster 5	**BA 45,46**	-48	+40	+6	6.03	L	2220	
Frontal Pole								
pars triangularis								
Cluster 6		-52	-42	+44	5.54	L	1838	
Inferior Parietal Lobe								
Rum>BPR		NS						

Cluster	X	Y	Z	Z	L/R	K	Uncor p<.01
Rum>Count							
Cluster K	+28	+2	-22	3.09	R	118	
Amygdala							
Cerebral Cortex							
Dist>Count							
Cluster L	+28	+2	-22	3.13	R	52	
Amygdala							
Cerebral Cortex							
Anterior Parahippocampal Gyrus							

Table 1.1. Group level BOLD results thresholded at cluster-corrected p<.05 (top chart) and uncorrect p<.01 (bottom chart). Significant clusters surrounding peak MNI (x, y, z) coordinates are listed as well as cluster Z-values. All reported values reached cluster extent threshold corrected significance of p<0.05. K values correspond to spatial extent (i.e. number voxels) and L/R indicate laterality of findings. (BPR=Big Picture Reappraisal, Dist=Distraction, Rum=Rumination) NS=not significant.

Discussion

The present study investigated the neural substrates of emotion regulation with regard to a real-life rejection experience. The study utilized a novel paradigm with prompts to elicit cognitive processing and alter mood. It was hypothesized that big picture reappraisal would activate regions associated with cognitive control of emotion and attenuate negative arousal. Rumination was hypothesized to increase negative mood/emotion, compared to distraction and big picture reappraisal, caused by the rejection experience. Big picture reappraisal and distraction were hypothesized to improve mood compared to rumination.

Big picture reappraisal was hypothesized to engage brain regions underlying cognitive control including the dlPFC, parietal lobe, and cerebellum. Though the activation of the dorsolateral prefrontal cortex was not significantly greater in big picture reappraisal compared to rumination, active regions included bilateral superior parietal cortex and right cerebellar lobule VI which are involved in aspects of cognitive control including insight, abstraction, and working memory (Ochsner, Silvers, & Buhle, 2012; Ramachandran, 1995; Stoodley & Schmahmnn, 2009). It was also hypothesized that when compared to distraction, big picture reappraisal would lead to increased activation in mPFC due to increased self-referential thinking, as well as aspects of executive functioning including working memory and abstraction (Johnson, Nolen-Hoeksema, Mitchell, & Levin, 2009, Ray et al., 2005). Though activation of this medial portion of the PFC was not significant when comparing big picture reappraisal to distraction, there was significant activation in left OFC (BA 10) which is implicated in attributing value and valence to stimuli and regulating/attenuating arousal (Ochsner, Silvers, & Buhle, 2012). The finding that distraction resulted in activation of left dlPFC suggests that distraction also involves some aspects of cognitive control, possibility due to shifting attention away from thinking about the rejection experience to creating a mental image (Hare, Camerer, & Rangel, 2009). Together, these results suggest that there are distinct brain regions associated with implementing the cognitive coping strategies of big picture reappraisal and distraction.

It was hypothesized that rumination would result in greater amygdala activation compared to big picture reappraisal. Amygdala activation was not significant at a strict, cluster-corrected $p<.05$ level. However, results of exploratory analyses yielded some evidence supporting the usefulness of big picture reappraisal to attenuate negative arousal. When the analysis was completed with a cluster-uncorrected threshold, and when comparing conditions to an active control, right-side amygdala activation was observed in both the distraction and rumination conditions, but was not found in the big picture reappraisal condition. This finding is important and suggests that the absence of negative arousal is a component of the mechanism of action in big picture reappraisal.

With regard to self-reported mood, it was hypothesized that mood would be more positive in the distraction and big picture reappraisal conditions than in the rumination condition. Overall, when contrasting big picture reappraisal, rumination, and distraction during both runs, there was a significant mood by treatment interaction. Though distraction significantly improved mood compared to big picture reappraisal and approached significance compared to rumination towards the beginning of the task, the effectiveness of distraction considerably declined over time. Overall, mood ratings results did not support hypotheses and there are several factors to consider with regard to these unanticipated findings. It could have been that given the multiple task demands (i.e. counting backwards, thinking about distress in different ways, mood ratings) occurring consecutively within a short time period the participant had difficulty attending to their mood. Along these lines, the participants could have had difficulty assessing small changes in their mood over the course of the task. It is also possible that the small sample size did not have sufficient power to detect group differences in mood.

A goal of this study was to investigate the neural correlates of a specific type of reappraisal strategy which could be applied in real-life with a novel reappraisal paradigm. Importantly, left OFC, cerebellum, and superior parietal lobe activation during reappraisal is consistent with some previous findings (Ochsner, Silvers, & Buhle, 2012). Big picture reappraisal compared to distraction was associated with activation of left OFC and when compared to rumination was associated with parietal and cerebellar activation, which are areas that facilitate cognitive control of emotion and support functions such as working memory, abstraction, valuation of stimuli, as well as insight. Interestingly, Kross and colleagues (2009) also found left PFC activation in a condition similar to reappraisal; however, this study also found this activation in a rumination condition and this was not found in the current study. As previously mentioned, the OFC is associated with attributing value and valence to stimuli and regulating/attenuating arousal (Ochsner, Silvers, & Buhle, 2012) and parietal cortex has been associated with insight and awareness in previous research and those with lesions in this region can have anosagnosia, or a lack of self-awareness (Ramachandran, 1995). In addition, right cerebellar lobule VI is associated with working memory and attention (Desmond, Gabrieli, Wagner, Ginier, & Glover, 1997; Stoodley & Schmahmann, 2009) and supports contralateral frontal regions associated with language processing and executive functioning (Allen et al., 2010; Stoodley & Schmahmann, 2009).

There was attenuated amygdala response in this experiment compared to some previous findings from fMRI emotion regulation paradigms. Importantly, this could have been related to an overly conservative analysis. Amygdala activation in the cluster-corrected analysis may have been attenuated by a threshold that was too strict (cluster size of 10) for the relatively small amygdala volume (1000-3000 $mm^{3)}$. This may have contributed to requiring a more liberal, uncorrected threshold to observe activation. In addition, the attenuated amygdala response could have could have been related to the use of a real-life rejection experience in this study. Most previous reappraisal fMRI paradigms with a rumination condition have used impersonal pictures or films that are arousing (e.g. Ray et al., 2005) and perhaps a negative autobiographical memory like a rejection experience did not instigate significant arousal necessary for activation of amygdala at a strict, cluster-corrected threshold. Perhaps the rejection experience instigated more feelings of sadness as oppose to high levels of negative arousal that may have been necessary for significant amygdala activation. Relatedly, though Kross and colleagues did not explicitly state hypotheses regarding amygdala activation, this study utilized negative autobiographical memories during rumination in an fMRI paradigm and also did not report activation of the amygdala.

The current study sought to shed light on the neural underpinnings of emotion regulation regarding real-life distress. Specifically, I wanted to explore the neural correlates of big picture reappraisal, which has been effective at reducing rumination in college students (Rude, Mazzetti, Pal, & Stauble, 2011). Rumination and distraction were used as comparison conditions because they are commonly used emotion regulation strategies and can lead to ineffective coping long term (Morrow & Nolen-Hoeksema, 1990; Nolen-Hoeksema,Wisco, & Lyubomirsky, 2008). The results of this study demonstrated that the neural correlates of big picture reappraisal compared to rumination and distraction resulted in increases in aspects of cognitive control as evidenced by superior parietal, cerebellum lobule VI, and OFC activation. Big picture reappraisal and distraction resulted in prefrontal activation in distinctly different regions suggesting these two coping strategies employ different aspects of cognitive control. In addition, amygdala activation was evident only during rumination and distraction, suggestive of negative arousal during these two conditions. Together these brain imaging findings indicate that reappraising distressing life events by taking into account the larger context, or "big picture" of adversity helps facilitate cognitive processing by enhancing aspects of cognitive control and diminishing negative arousal.

Strengths and Limitations

There were several strengths of the current study. This paradigm took reappraisal fMRI tasks beyond overly-simplistic instructions and impersonal emotion-evoking stimuli. The reappraisal activation was evident when considering an *actual* emotion-eliciting event utilizing specific reappraisal instructions that have significant applicability to real-life. In addition, the study utilized a rigorous, randomized design allowing for inferences to be made about the data without confounding factors becoming a significant issue. Further, the participants were rigorously screened prior to admission into the study to rule out other possible factors that could have contributed to variance in brain activation beyond the treatment conditions. A limitation of the study was that the sample size was relatively small and each of the treatment groups had few numbers of participants. This likely contributed to insufficient power to detect differences for the mood data in particular. In addition, during the task the study primed participants to think about the rejection experience on a slide immediately prior to the condition-specific prompt (see Figure 1.1) rather than including the rejection experience prime on the condition-specific prompt slide itself. This may have attenuated participant focus on the rejection experience when considering condition-specific prompts. Finally, though using only healthy women participants reduced variability in a relatively small sample size, the generalizability of these findings to men and clinical populations is also limited.

CHAPTER TWO

Extended Document

Definitions and Conceptualization of Emotion Regulation

Sometimes emotions are destructive, and sometimes they are helpful. The challenge is to find ways of regulating our emotions so that we retain their helpful features, while limiting their destructive aspects. Emotion regulation is an attempt to influence the experience and expression of emotion (Gross, 1998; 2007). There are extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions (Thompson, 1991). Different models of emotion regulation exist; however, the one that has generated the most theoretical and research interest is the conceptualization put forth by Gross.

Gross's model of emotion regulation differs from other models in that emotion regulation is conceptualized as strategies along a timeline, or continuum, of unfolding emotional responses. With the continuum concept, emotion regulation begins with an evaluation of an emotional cue, which subsequently triggers a series of coordinated sets of response tendencies that involve experiential, behavioral, and physiological systems. Most of the research generated from this model has focused on the phases of this continuum that Gross has labeled antecedent-focused and response-focused emotion regulation strategies. With this conceptualization, Gross's research has focused on examining the antecedent-focused strategy of reappraisal and the response-focused strategy of expressive suppression as emotion regulation strategies at two different time points along this continuum (see Figure 1.1). Reappraisal is theorized to occur at the cognitive, antecedent-focused level; whereas expressive suppression, or suppressing emotional facial expressions, is thought to occur at the response-focused, behavioral level. A more detailed description of Gross's theory follows.

According to Gross (1998), the experience of an emotion sets the process of emotion regulation into action. Antecedent-focused strategies are employed prior to responding to the emotion. This set of strategies attempts to modify the likelihood or experience of a stressor to prevent or reduce the amount of distress it creates. Response-focused strategies are things done once the emotion is underway. Within these two types of strategies, Gross posits a process model of emotion regulation that highlights five families of emotion regulation strategies (Gross & Thompson, 2007). Some of these emotion regulation families have received more research attention than others, but all five will be described below and can be seen in Figure 2.1. The five families include situation selection, situation modification, attentional deployment, cognitive change, and response modulation. Four of these families are considered antecedent-focused strategies, including situation selection, situation modification, attentional deployment, and cognitive change. The fifth family is response modulation, which is considered to be a response-focused strategy.

The first family, **situation selection**, involves taking actions to make it more likely that the situation will give rise to desirable emotions. Thus, individuals may try to avoid situations that are known/thought to bring about negative emotions (e.g. avoiding confrontation), even if the long-term consequences could be detrimental. Secondly, **situation modification** is conceptualized as an attempt to modify the situation directly so as to alter its emotional impact (e.g. making a joke about a bad situation). In the stress and coping literature, this is known as "problem-focused coping" (Lazarus & Folkman, 1984). Situation modification involves modifying, or problem-solving with external, physical environmental factors. The third family is **attentional deployment**. Attentional deployment involves regulating emotions without changing the environment, or influencing emotional responding by redirecting attention within a given situation. Attentional deployment can involve physical withdrawal of attention (e.g. covering the eyes), internal redirection of attention (e.g. distractions), and responding to external redirection of attention (e.g. a parents redirection of a hungry child by telling the child an interesting story). In this conceptualization, Gross considers rumination “inflexibility in inner-directed attention.”

The fourth family is **cognitive change**. This refers to changing one or more appraisals in a way that alters the situation’s emotional significance by changing how one thinks either about the situation itself or about one’s capacity to manage the demands it poses. Reappraisal is a form of cognitive change that has been widely researched (e.g. Gross, 2002). Lastly, **response modulation** refers to influencing physiological, experiential, or behavioral responses directly. Expressive suppression, which is an attempt to decrease ongoing emotion-expressive behavior, is an example of response modulation.

Figure 2.1.

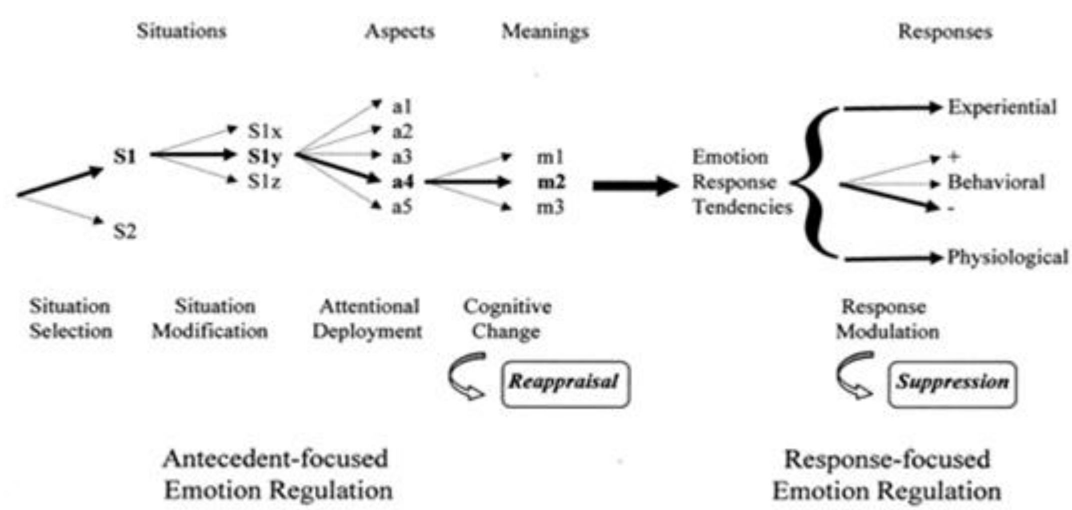


Figure 2.1. Gross’s model of antecedent and response-focused emotion regulation from Gross (2001).

Emotion Regulation Strategies: Focus of the Current Study

The following emotions regulation strategies: acceptance, avoidance, problem-solving, suppression, rumination, and reappraisal, were recently featured in a meta-analytic review by Aldao, Nolen-Hoeksema, and Schweitzer (2010). These strategies were chosen due to the extensive research on their relationship to psychopathology, particularly anxiety and depression. Among the aforementioned strategies, reappraisal and rumination will be the focus of the current study. Aldao and colleagues note that reappraisal is among one of the most researched emotion regulation strategies and involves generating benign or positive interpretations or perspectives on a stressful situation as a way of reducing distress (Gross, 1998), as oppose to maladaptive appraisal processes, which are thought to be at the core of depression and anxiety according to cognitive models (Beck, 1976; Salkovskis, 1998). In contrast to reappraisal, rumination is consistently found to be quite maladaptive, interfering with problem-solving skills, immobilizing individuals into indecision, and contributing to and maintaining depression (Ward Lyubomirsky, Sousa, & Nolen-Hoeksema, 2003).

Another emotion regulation strategy, which is often utilized to counteract the effects of rumination in experimental research, is distraction. Distraction involves taking attention away from an emotion-eliciting situation by refocusing on positive or neutral stimuli. Unlike rumination, distraction is found to be beneficial over the short-term; however, long-term use of distraction to cope with distress can become problematic and manifest as avoidance and suppression, which are quite maladaptive. Distraction will also be utilized in this study.

Descriptions and Correlates of Emotion Regulation Strategies

Rumination

Rumination has been conceptualized in many ways, most notably by Nolen-Hoeksema. She theorized that rumination is a maladaptive response style in which individuals respond to distress in a way that involves repetitively and passively focusing on symptoms (Nolen-Hoeksema, 1991). The content of ruminative thought in depressed individuals is typically negative in valence, similar to the automatic thoughts, schema, and negative cognitive styles that have been studied extensively by cognitive theorists (Beck, 1976). An extension of the original definition by Nolen-Hoeksema, Wisco, & Lyubomirsky (2008) is that rumination is also a process of thinking perseveratively about one's feelings and problems, rather than in terms of the specific depressive content of thoughts.

Other conceptualizations of rumination elaborate on this premise. Martin and Tesser (1996) define rumination as "a class of conscious thoughts that revolve around a theme and that recur in the absence of immediate environmental demands requiring the thoughts." Other definitions of rumination include that of Conway, Csank, Holm, and Blake (2000, p. 216), stating that rumination: consists of repetitive thoughts concerning present distress and the circumstances surrounding the sadness. These thoughts are noted to not be socially shared or goal directed, nor do they lead to plans of action. This problematic response style amplifies depression by increasing the likelihood of negative response bias, enhancing the effects of existing maladaptive cognitive styles by bringing maladaptive cognitions to mind more often, and interfering with attention and concentration in part by inducing an excessive, negative self-focus (Morrow and Nolen-Hoeksema, 1990).

Rumination and Cognition

Rumination is associated with a number of cognitive problems. These include perseveration, a weak problem-solving orientation, poor problem-solving skills, and negative appraisals of situations. In one study concerning cognitive problems associated with rumination, Davis and Nolen-Hoeksema (2000) found that ruminators have enhanced difficulty with inhibition and cognitive flexibility on laboratory measures, with responses marked by perseveration and difficulty shifting sets. Similarly, Philippot and Brotoux (2008) explored the effects of induced rumination versus distraction on cognitive functioning of college students and found that rumination led to decreases in inhibition in dysphoric individuals.

Along these lines, Whitmer and Banich (2007) also found cognitive problems associated with rumination. In this study, they found that in a nondepressed sample, individuals who had high scores on the ‘reflection’ and ‘brooding’ subscales of a rumination measure had more difficulty inhibiting previously learned responses. Watkins & Brown (2002) also examined this association between cognition, particularly aspects of executive functioning and rumination, and determined that a causal relationship existed between rumination and executive dysfunction as measured by a random number generation task. To explain this phenomenon, Nolen-Hoeksema and colleagues posit that perhaps rumination, and other mind-occupying emotion regulation strategies, “fill” cognitive space that diminishes available executive resources (Davis and Nolen-Hoeksema, 2000). The possibility also exists that limited executive capacity leaves fewer cognitive resources available to regulate emotions, particularly in depression (Joorman & Gotlib, 2010).

Neural Correlates of Rumination

To further understand the relationship between rumination and changes in cognitive functioning, research on the neural underpinnings of rumination has proliferated in recent years. A few regions of interest that have been associated with rumination are areas involved in working memory (dorsolateral frontal cortex, parietal cortex, and cerebellar cortex), abstraction and attention (dorsolateral and anterior prefrontal cortex) and self-referential thinking (medial prefrontal cortex). In addition, rumination also generates a lot of distress and emotional arousal, so not surpringingly, we see activation in areas associated with emotions, decision making, and reward anticipation (anterior cingulate cortex), and fear response and negative emotional arousal (amygdala).

Seminal research on the neural correlates of rumination was conducted by Siegle and colleagues. In this study, nondepressed and depressed individuals responded to negatively-valenced words. Results showed that those with depression had greater increases in amygdala activation. With regard to rumination, the study found moderate positive associations between self-reported rumination and amygdala activity for both groups (Siegle et al., 2002). Similar results were found in a study by Ray and colleagues. In this study, they examined differences in patterns of brain activation for ruminators versus nonruminators in a nonclinical population. Participants were instructed to “increase” or “decrease” negative affect when looking at images from a normative database. Findings demonstrated that compared to nonruminators, ruminators had greater increases in bilateral amygdala activation when increasing negative affect. In addition, when ruminators were decreasing, or down-regulating negative affect, greater decreases in activation were seen in the medial prefrontal and anterior cingulate activation, implicated in self-focused thought (Ray et al., 2005).

These results imply that the negative affect ruminators were generating in response to images from a normative database (not self-relevant) were causing them to think self-relevant thoughts. These findings indicate that ruminators are more easily negatively-aroused than nonrumintors, and have a more difficult time disengaging from negative emotions and self-focused thought processes than nonruminators. These studies provided a useful first-glance at the neural substrates of ruminative-type thinking.

In another rumination study by Denson and colleagues (2009), fMRI was used to study the neural correlates of anger and angry rumination. Participants were induced to ruminate by being verbally insulted about their performance on a task while in the MRI scanner. In this study, activity in the medial frontal cortex was also positively correlated with self-reported rumination. Interestingly, increased activation in the hippocampus, a structure involved in emotion and memory, and activation in the cingulate cortex following the provocation, predicted subsequent self-reported rumination, with ruminators having greater activation in these areas.

The neural underpinnings of the self-relevant quality of depressive rumination was further researched by Johnson, Nolen-Hoeksema, Mitchell, & Levin (2009). This study looked at neural substrates of rumination in a depressed versus nondepressed sample with a region of interest approach in the anterior medial cortex (e.g., medial frontal gyrus, anterior cingulate cortex (ACC)) and posterior medial cortex (e.g., posterior cingulate cortex, precuneus), which have been associated with self-referential processing (Fossati, et al., 2003; Johnson, et al., 2002; Johnson et al., 2006). They were looking at the discrepancy in findings that the anterior medial cortex has been recruited for both positive and negative self-referential thought in recent studies (Mitchell et al., 2009; Ray et al., 2005).

The participants in the study either thought about hopes and aspirations, which were thought to be more positively self-relevant, or more neutral to negatively-valenced self-referential thoughts, such as duties and obligations. The found that for both groups, there was increased activation in the anterior medial cortex (medial frontal gyrus and ACC) when thinking about positive, self-relevant hopes and aspirations. In contrast, there was activation in more posterior medial regions (precuneous and posterior cingulate cortex) when thinking of negative, self relevant duties and obligations. For the depressed group specifically, they found less deactivation in medial frontal cortex for duties and obligations, indicated more difficulty disengaging from more negatively-valenced self-reflection.

Overall, control participants showed greater activation in mPFC compared with depressed participants in the negative condition. This pattern of activation would be expected if this sub-region of mPFC is associated with positively-valenced self-focus (Johnson et al., 2006; Sharot, Riccardi, Raio, & Phelps, 2007). They noted that this could be because the positive thoughts participants *do* generate feel less positive, and/or negative thoughts offset the impact of positive thoughts.

Distraction

Distraction was originally conceptualized by Nolen-Hoeksema as an alternative to rumination. The response-styles theory of depression (Nolen-Hoeksema, 1987) proposes that individuals who engage in distracting responses to their depressed mood will experience improved mood and temporary relief from depression symptoms (Nolen-Hoeksema and Morrow, 1991). Distraction often provides short term relief from distress, helping individuals to refocus their attention, thus distracting from the emotional valence of the situation or event. Studies have found that when dysphoric participants are induced to distract from negative thoughts, this can lead to positive appraisals of events and less distress.

Morrow and Nolen-Hoeksema (1990) found that distracting thoughts and/or activities have beneficial effects on rumination to varying degrees, such that those who ruminate less are able to reduce depressive symptoms by distraction, whereas those who ruminate more had lesser remediation of depressed affect when distracted. Distraction can also be considered an emotion regulation strategy, such that it can alter the experience and expression of emotions. The refocus of attention during distraction causes a change in internal focus, such as remembering thoughts and feelings inconsistent with the undesirable emotional state.

Distraction and Cognition

Distraction has been associated with changes in cognitive functioning, such as memory and problem-solving ability. Researchers posit that distraction leads to reduced negative bias in autobiographical memory and contributes to improved problem solving ability temporarily (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). In support of these hypotheses, laboratory studies have shown that depressed people made to engage in a ruminative task subsequently generated fewer possible solutions to life problems and lower-quality solutions to interpersonal problems than depressed people who first engage in a distracting task (Morrow, 1990). Distraction has also been found to improve social problem solving ability (Donaldson & Lam, 2004), and to reduce overgeneral autobiographical memory retrieval (Sutherland & Bryant, 2007). However, these effects have only been found over the short-term, and chronic use of distraction is thought to lead to maladaptive avoidance of negative emotions over time (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008).

Long term use of distraction and avoidance often leads/contributes to psychopathology, particularly anxiety disorders. Findings have been mixed with regard to the relationship between cognition and distraction/avoidance. Some research has found that avoiding unwanted memories and thoughts is associated with greater inhibition and reduced perseveration in depressed and depression-vulnerable populations (Anderson et al., 2004; Levy & Anderson, 2008), while other studies have found that reduced inhibition is related to greater use of avoidance (Joormann and Gotlib, 2010).

Neural Correlates of Distraction

As in questionnaire-based research, the neural correlates of distraction have often been studied in contrast to rumination. Distraction in these studies often involves focusing on concrete objects or neutral information. Generally, regions of interest related to distraction are areas involved in visual processing (regions of the occipital cortex, including cuneous and fusiform gyrus). In addition, studies have reported how distraction alters neural activity from areas related to ruminative thought processes, such as regions associated with self-referential thinking and attention (frontal cortex), emotions and cognitive abilities, such as decision making and reward anticipation (anterior cingulate cortex), and emotional arousal (amygdala).

One study by Cooney, Joormann, Eugene, Dennis & Gotlib (2010) explored the neural correlates of rumination (self-focus) compared to each of two types of distraction (abstract distraction and concrete distraction) in depressed and healthy individuals. In the ruminative self-focus group, participants were given traditional rumination statements, such as "Think about your personality." In the concrete distraction group, participants were given traditional distraction statements utilizing non-emotion eliciting material, such as "Think about a row of shampoo bottles." In the novel abstract distraction condition, participants were given statements such as, "Think about what contributes to team spirit."

Results indicated that rumination versus concrete distraction and rumination versus abstract distraction yielded different patterns of activation. When comparing rumination to concrete distraction, control participants showed increased activation in areas of visual processing (cuneous and fusiform gyrus), compared to depressed participants. In addition, those with depression showed greater activation in ACC and orbital frontal cortex (OFC). For the abstract distraction versus rumination condition, activation was greater for the depressed group in the amygdala, ACC, mPFC, and dlPFC. These findings indicate that different distraction conditions can yield somewhat different results when contrasted with rumination, and rumination activates regions associated with emotion and self-referential processing.

Reappraisal

Unlike distraction and rumination, reappraisal is consistently regarded as a helpful emotion regulation strategy across a variety of contexts. Reappraisal involves changing the way a situation is mentally construed in such a way that there is a change in the person's emotional response to that situation (Gross, 2002). Cognitive models of depression posit that maladaptive reappraisal strategies can cause depression (Beck, 1976), but adaptive reappraisal strategies can lead to positive emotional and physical responses to emotional stimuli (Gross, 1998). Gross and colleagues have found evidence to suggest that reappraisal occurs fairly early on in the emotiongenerative process and alters the experiential and physiological components of the emotional response (Gross, 2002). Experientially, reappraisal is found to decrease the experience of negative emotions and is associated with greater positive emotion experience. In addition, physiological responses to reappraisal include decreased expressive behavior, such as reduced sympathetic nervous system activation, as measured by heart rate. Individual-difference studies have shown that frequent use of reappraisal is also related to fewer symptoms of depression (Gross and John, 2003; John and Gross, 2004).

Reappraisal and Cognition

Reappraisal involves an effortful cognitive process requiring attention and abstraction ability (Berkman & Lieberman, 2009). Cognitive flexibility, or the ability to shift attention and think about a situation or stimuli from various perspectives, has predicted reappraisal success in one recent study (Gyruak, et al., 2009). Similarly, a study by Joorman and Gotlib (2010) found that depression-vulnerable participants who had difficulty with reappraisal demonstrated difficulty with the ability to inhibit prepotent responses. Performance on a conflict-monitoring task also predicted successful reappraisal, as operationalized by measuring dampened aggressive reactions to anger provocation in a laboratory setting (Wilkowski, Robinson, & Troop-Gordon, 2010). Further, individual differences in reappraisal were found to predict successful cognitive performance in response to negative feedback (Raftery& Bizer, 2009). Overall, it seems that better cognitive functioning is related to better reappraisal ability.

Neural Correlates of Reappraisal

Reappraisal has received much focus in functional neuroimaging research. Not surprisingly, some regions associated with rumination have also been found to be related to reappraisal, including areas involved in self-referential thinking, emotions, inhibition (dorsal and anterior cingulate cortex), and emotional arousal (amygdala), as well as regions associated with working memory (dorsolateral frontal cortex, parietal cortex, inferior cerebellar cortex), and abstraction and attention (lateral and medial frontal cortex).

In seminal research by Ochsner, Bunge, Gross, and Gabrieli (2002), neural activation was compared between a reappraisal condition ("interpret negative photos so you no longer feel negative in response to them") and passive viewing condition ("let yourself respond emotionally to each photo") when viewing negative photos. Compared to passive-viewing, reappraisal recruited regions of the left lateral prefrontal cortex and dorsomedial prefrontal cortex. Participants' self-reported emotion regulation success was associated with increased activation in the dorsal anterior cingulate cortex (dACC), a region frequently implicated in conflict monitoring, during tasks that require the inhibition of a prepotent response. Finally, reappraisal-related increases in left ventrolateral prefrontal cortex were negatively correlated across subjects with activation in regions implicated in evaluating affective salience, such as the amygdala and medial OFC.

Overall, the left ventrolateral prefrontal cortex and dACC were involved in taking attention away from negatively-valenced stimuli and refocusing in a way that decreases negative emotional responding. Several other studies have replicated the basic finding of increased left prefrontal cortex and dACC and decreased amygdala and OFC activation during reappraisal (Kim & Hamann, 2007; Ochsner et al., 2004; Phan et al., 2005).

In a recent review of functional neuroimaging research in emotion regulation by Ochsner, Silvers, & Buhle (2012), a model of the neural substrates involved in emotion regulation, and reappraisal in particular, is proposed. The model is related to the theoretical model of the emotion generation and regulation continuum in (Gross, 1998) and specifies how prefrontal and cingulate control systems modulate activity in perceptual, semantic, and affective systems as a function of regulatory goals.

Figure 2.2.

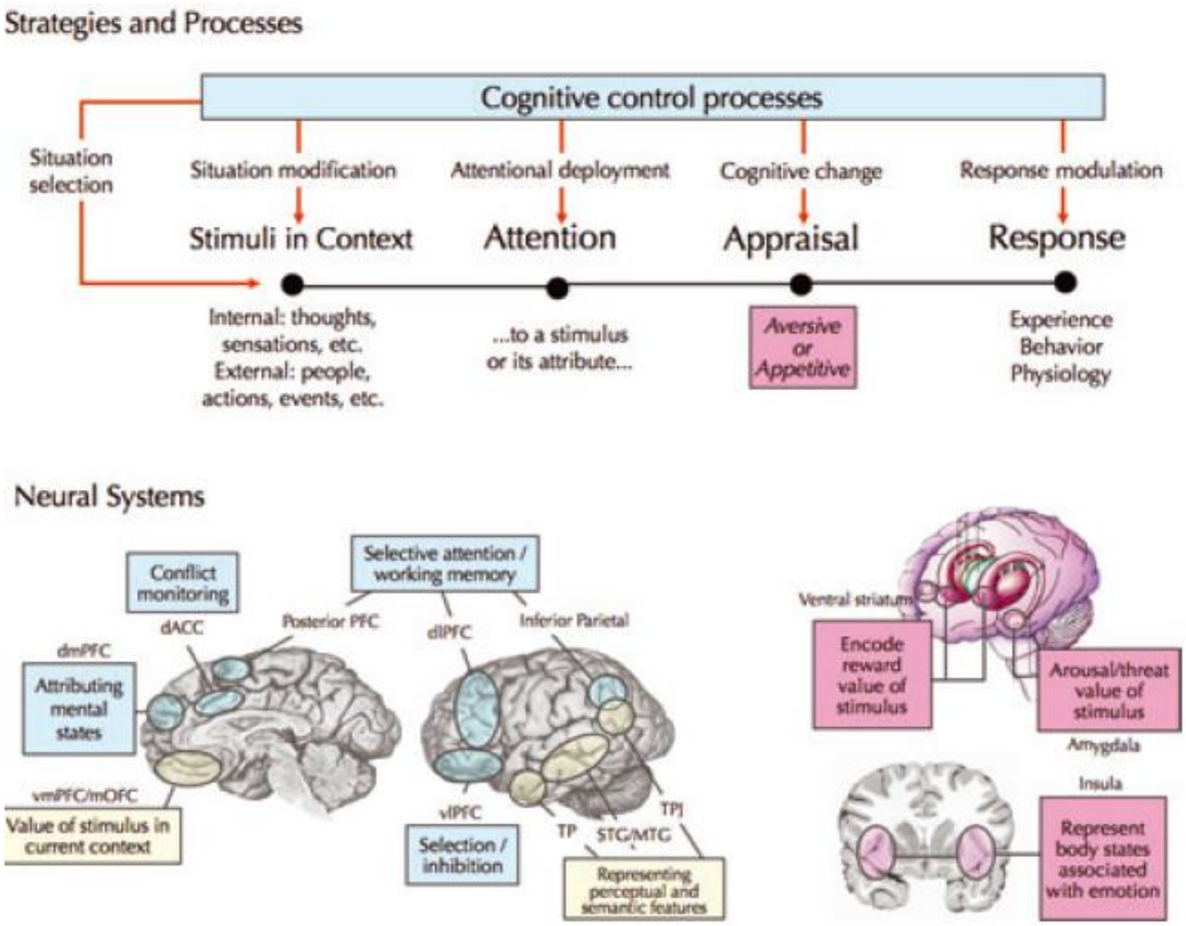


Figure 2.2. Model of cognitive control of emotion (MMCE) as conceptualized by Ochsner, Silvers, & Buhle (2012). The blue box indicates the neural systems involved in the cognitive control process and the pink box indicates the neural systems involved in generating emotion. Regulatory responses are in the blue boxes for "neural systems" and systems involved in generating emotional responses are in the pink boxes on the left. The yellow boxes indicate systems with undefined roles in reappraisal.

The review notes four major regions have been extensively studied in the generation of emotion including 1. Amygala, 2. Ventral Striatum, 3. Ventromedial Prefrontal Cortex and 4. Insula. Amygdala was noted to perceive and encode stimuli ranging from rewards or punishments with regard to facial expression of emotion, aversive or pleasant images and films, as well as arousing stimuli. Overall, they noted that amygdala has been overwhelmingly found to detect cues signaling potential threat and fear response. Ventral Striatum was related more to warning prediction or reinforcing outcomes while ventromedial prefrontal cortex integrates information from amygdala and ventral striatum with inputs from medial temporal systems (which provide historical information and other memory cues) and generates behavioral goals. Generally, the insula was noted to represent negative affective experience.

According to the review, for emotion regulation the basic control system-affect system relationship of the MCCE, which has been largely supported in the literature, is the idea was the prefrontal and cingulate systesm would support control processes that modulate posterior and subcortical systems that generate emotion. Three systems are implicated 1. Dorsolateral and posterior prefrontal cortex and inferior parietal regions implicated in selective attention and working memory used to direct attention to stimulus for reappraisal and hold in mind reappraisal goals, 2. Dorsal regions of anterior cingulate cortex implicated in performance monitoring, and 3. Ventrolateral prefrontal cortex implicated selection and inhibition of appropriate responding possibly using semantic memory.

In this review, it was noted that out of 43 studies that have researched reappraisal in neuroimaging paradigms, only 1 study to date has investigated the neural substrates of reappraisal with regard to an autobiographical memory. The majority of studies have used impersonal films or pictures to elicit emotion, whereas Kross, Davidson, Weber, & Ochsner (2009) utilized arousing, negative autobiographical memories for this purpose. In this study, a small sample of neurotypical participants appraised a memory utilizing a “feel,” “analyze,” or “accept” strategy. The “feel” strategy was conceptualized to be similar to rumination while the “analyze” strategy was designed to be more objective. The “accept” strategy was used as a distancing instruction to elicit reduced negative arousal. They found some results that were consistent with previous image-based paradigms including left prefrontal activity in the three strategies. They found that subgenual ACC and mPFC were more activated in the “feel” strategy relative to the “accept” strategy. Notably, this paradigm did not elicit the amygdala activation in the “feel” condition that is typical of rumination conditions in emotion regulation studies. The novel use of the autobiographical memory to elicit emotion in this study was an interesting and more translational way of utilizing neuroimaging to study emotion regulation.

Overgeneral and Inconsistent Instructions in Reappraisal Experiments

In general, reappraisal involves changing a situation’s meaning in such a way that there is a change in the person’s emotional response to that situation that can lead to positive emotional and physical responses to emotional stimuli (Gross, 1998; 2002). In the aforementioned review by Aldao and colleagues, reappraisal was found to be a particularly helpful strategy across a variety of contexts. A myriad of different instructions to guide reappraisal have been studied, some instructions being quite general, and some being very specific. For instance, Gross (1998) utilized specific perspective-taking reappraisal directions, such that when participants were looking at a picture of a disgusting amputated arm, they were instructed to “look at it as if it were a picture from a medical teaching film.” In this study reappraisal decreased the experience of disgust and had no observable physiological consequences.

Other studies have used more general instructions for reappraising a stimulus, such as “decrease negative affect” (Ray et al., 2005), “think objectively,” (Goldin, et al., 2008),” simply “reappraise” (Ochsner et al. 2002), or “analyze” (Kross, Davidson, Weber, & Ochsner, 2009). Though these general reappraisal conditions are found to be beneficial, the way in which participants are thinking about the stimulus in order to process and reappraise the emotion is somewhat indiscernible. These variations are problematic, as it is difficult to know what exactly is helpful for the person when they reappraise. Utilizing consistent, explicit directions for reappraisal is important for future research.

Big Picture Reappraisal

Big picture reappraisal stems from the construct of contextual thinking, which promotes awareness of the broader contexts in which adversity and distress occur, changing a situation's meaning by de-centering from the problem (Rude, 2011). Big picture reappraisal is closely related to the concept of mindfulness, promoting awareness of the broader contexts in which adversity and distress occur (Rude, 2011).

This mode of thinking involves considering a distressing event or situation while maintaining awareness of how the event and/or reactions to it fit into an extended time perspective (e.g. distress fluctuates and dissipates over time), the broader context of one's life (e.g. awareness of wanted and unwanted experiences), and broad human context (e.g. all people deal with adversity and distress and goals are fundamentally similar). In recent research by Rude, Mazzetti, Pal, & Stauble (2011), results demonstrated that thinking about an adverse situation through a contextual lens decreased ruminative thought and depressed mood.

Summary

In sum, three types of emotion regulation strategies are being featured here, including rumination, distraction, and reappraisal, specifically big picture reappraisal. Rumination has been consistently shown to enhance depressed mood by focusing repetitively on negative self-oriented information, emotions, and details, inhibiting ability to refocus and shift attention to more relevant topics. Unlike rumination, distraction is found to have beneficial short-term effects, but is problematic long-term due to promoting avoidance of unwanted emotions, leading to continued difficulties coping with distress. Reappraisal is found to be an effective emotion regulation strategy for managing negative emotional experiences and responses, and is associated with positive experiential and behavioral outcomes. A specific type of reappraisal, big picture reappraisal, involves thinking about a negative emotion-eliciting situation from a contextual perspective, and is found to be helpful in promoting awareness of emotional experience, while also improving mental health symptoms.

Adequate cognitive functioning is often an asset when regulating emotions. Researchers have hypothesized that rumination and other counterproductive emotion regulation strategies may be negatively correlated with executive functioning, even depleting cognitive resources (Davis & Nolen-Hoeksema, 2000). To learn more about this phenomenon, this study will use functional neuroimaging to examine the neural underpinnings of distraction, rumination, and big picture reappraisal.

Methodology

Approval by Human Subject Committee

The proposed study will be in compliance with the guidelines set forth by the Institutional Review Board for the Protection of Human Subjects at the University of Texas at Austin and with the Ethical Principles of the American Psychological Association (2002).

Prescreening

Before participants were enrolled in the study, potential subjects were prescreened with the Phone Screening Form (see Appendix B). This screen was conducted over the phone prior to admission into the study. The phone screening was utilized to gather demographic information, information pertinent to being able to go into an MRI machine, and information regarding social rejection. Specifically, in this phone screening participants will be asked about their social rejection experience in the past 6 months that still bothers them and answered questions regarding how hurt, sad, and upset they feel when thinking of the rejection experience. Information relevant to the study, such as mental and physical health information and MRI safety was also asked in the phone screen. Participants were excluded from the study if they reported having a current DSM-IV-TR diagnosis by a mental health professional or were currently in therapy or taking medications that could significantly affect brain chemistry. In addition, participants will be excluded if they are left-handed, as handedness is often an indicator of contralateral hemisphere language dominance and associated with brain organization and functionality.

Instruments

Phone Screening Form. (see full list of questions in Appendix B).

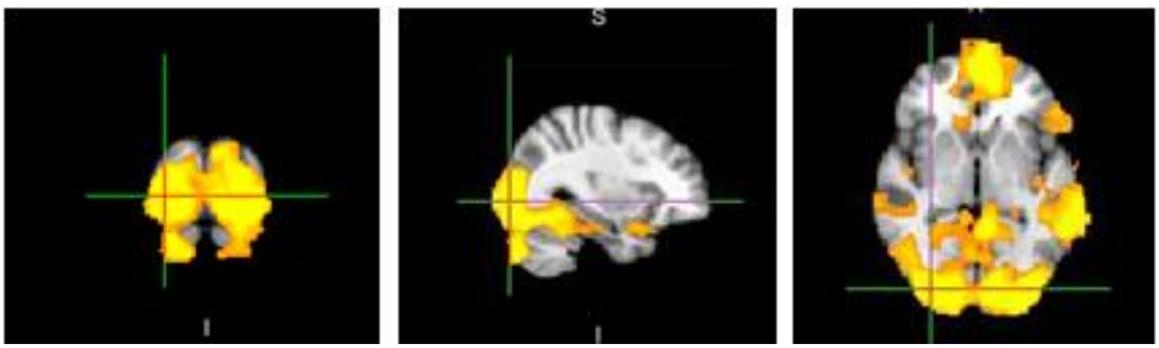
Social Rejection Description. The social rejection description will be a brief series of questions, asked previously during the phone screen, that concern participants' current feelings regarding their rejection experience (see Appendix C).

Writing Task. The writing instructions will be the following: "Write about your rejection experience in the past 6 months when the actions of a close friend or romantic partner led to feelings of rejection that still bother you. When writing you could contemplate: When did this happen? , Where were you?, How did the other person act?, How did you act?, What did you think?, What did you feel? Describe the event as vividly and with as much detail as you can."

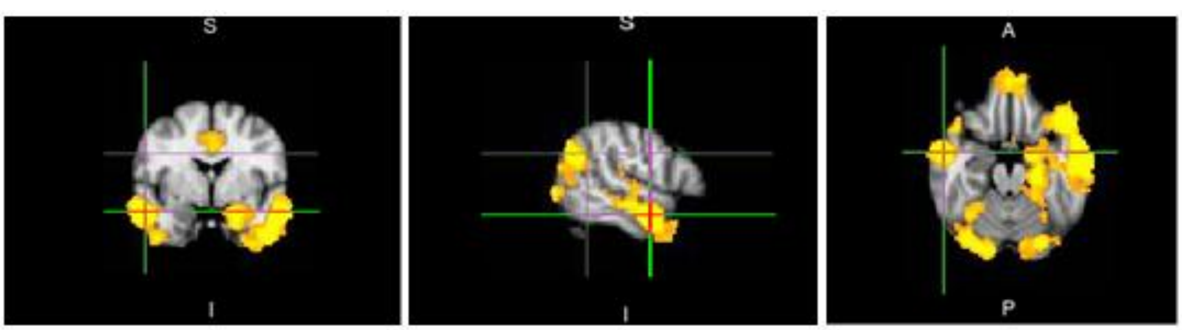
Results

Imaging Data.

Figures 2.3A-2.3G. Brain regions showing significant ($p<0.05$, FDR corrected) BOLD signal in Condition versus Counting contrasts. Big Picture Reappraisal > Counting, Rumination > Counting, and Distraction > Counting in the coronal, sagittal, and transverse views; respectively.

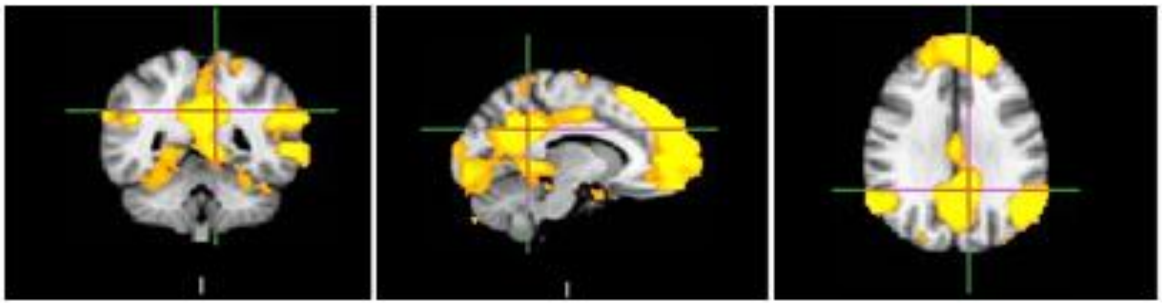


2.3A Big Picture Reappraisal>Count: Lateral Occipital Activation

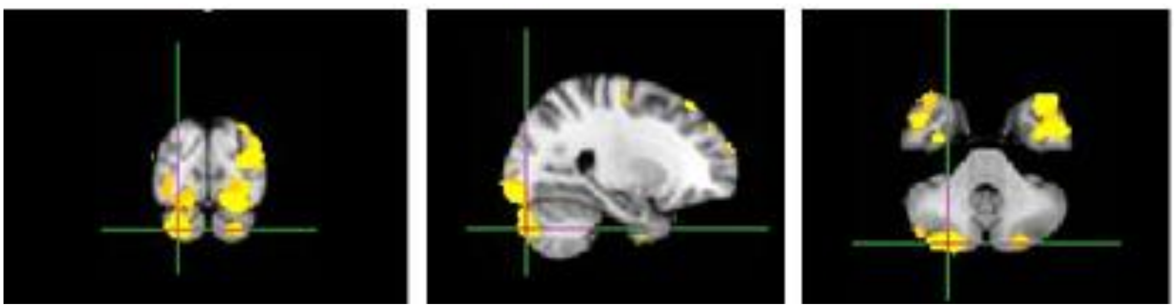


2.3B Rumination>Count Anterior Middle Temporal Gyrus

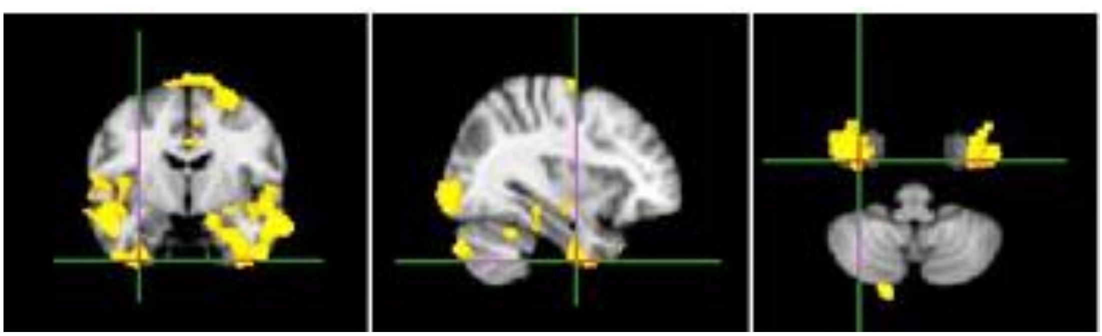
Figures 2.3A-2.3G (cont.)



2.3C Rumination>Count Posterior Cingulate Gyrus Activation

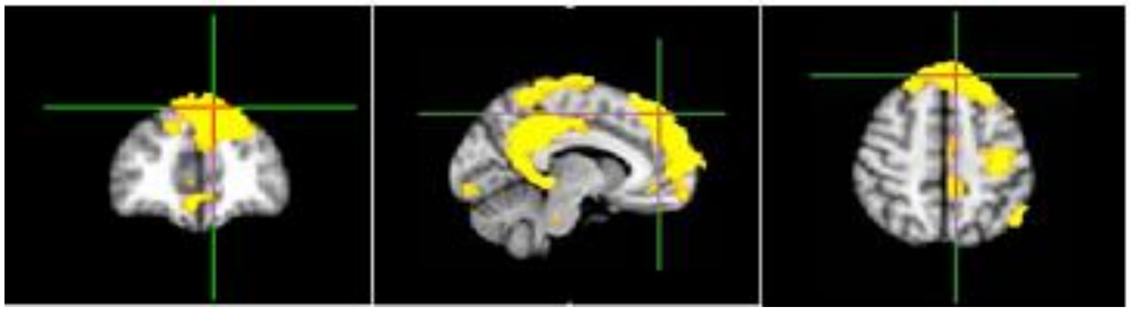


2.3D Distraction>Count Cerebellum Crus II

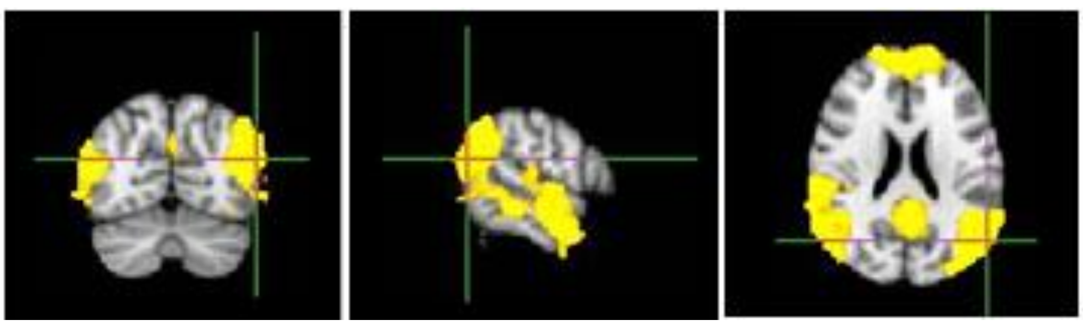


2.3E Distraction>Count Anterior Temporal Gyrus

Figures 2.3A-2.3G (cont.)



2.3F Distraction>Count Frontal Pole



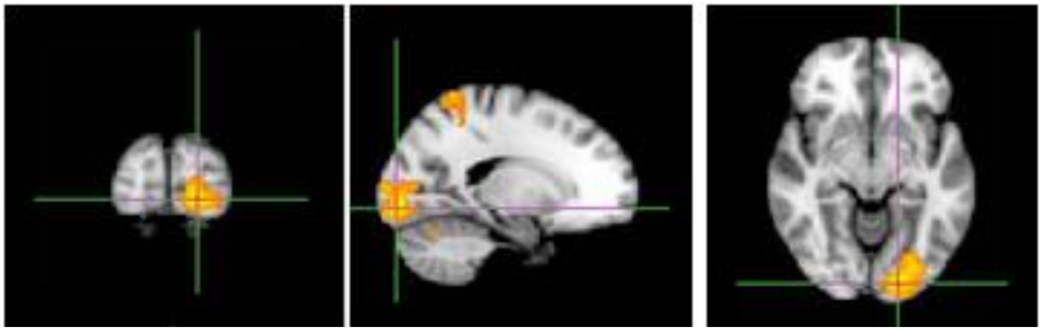
2.3G Distraction>Count Superior Lateral Occipital Cortex

Table 2.1.

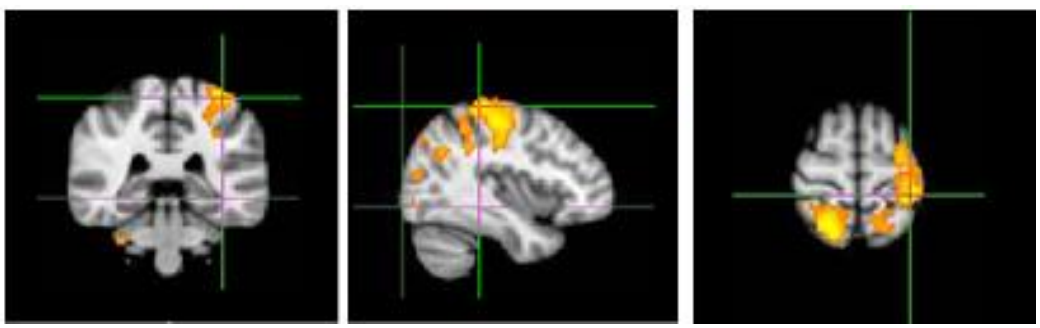
Cluster	X	Y	Z	Z/%	L/R	K	Cluster P
Big Picture Reappraisal>Count							
Cluster 2.3A	**+32**	**-88**	**-2**	**9.02**	**R**	**60288**	**<.05**
Inferior Lateral Occipital Cortex							
Occipital Pole				15%			
Occipital Fusiform Gyrus				3%			
Superior Lateral Occipital Cortex				1%			
Rumination>Count							
Cluster 2.3B	**+56**	**-2**	**-20**	**6.69**	**R**	**4023**	**<.05**
Anterior Middle Temporal Gyrus				16%			
Anterior Superior Temporal Gyrus				16%			
Posterior Middle Temporal Gyrus				7%			
Posterior Superior Temporal Gyrus				6%			
Cluster 2.3C	**-10**	**-48**	**+30**	**9.13**	**L**	**41245**	**<.05**
Posterior Cingulate Gyrus				53%			
Precuneous Cortex				7%			
Distraction>Count							
Cluster 2.3D	**+26**	**-84**	**-38**	**5.27**	**R**	**2091**	**<.05**
Cerebellum Crus II							
Cluster 2.3E	**+34**	**-6**	**-46**	**6.14**	**R**	**8456**	**<.05**
Anterior Temporal Fusiform				48%			
Posterior Temp Fusiform Cortex				20%			
Anterior Inferior Temporal Gyrus				14%			
Posterior Inferior Temporal Gyrus				5%			
Cluster 2.3F	**-8**	**+44**	**+50**	**6.35**	**L**	**8560**	**<.05**
Frontal Pole				64%			
Superior Frontal Gyrus				15%			
Cluster 2.3G	**-56**	**-68**	**+22**	**6.66**	**L**	**21971**	**<.05**
Superior Lateral Occipital Cortex				69%			
Inferior Lateral Occipital Cortex				3%			
Angular Gyrus				1%			
Middle Temporal Gyrus				1%			

Table 2.1. Group level BOLD results. Significant clusters surrounding peak MNI (x, y, z) coordinates are listed as well as cluster Z-values and percentage of brain regions associated with significant activation. All reported values reached cluster extent threshold FDR-corrected significance of $p<0.05$. K values correspond to spatial extent (i.e. number voxels) and L/R indicate laterality of findings.

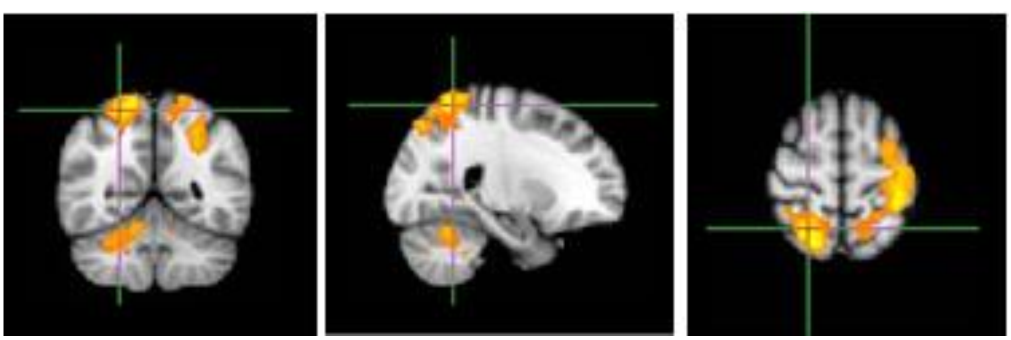
Figures 2.4A-2.4F. Brain regions showing significant (p<0.05, FDR corrected) BOLD signal in Condition contrasts Big Picture Reappraisal > Rumination and Big Picture Reappraisal > Distraction in the coronal, sagittal, and transverse views; respectively.



2.4A Big Picture Reappraisal>Rumination Occipital Pole

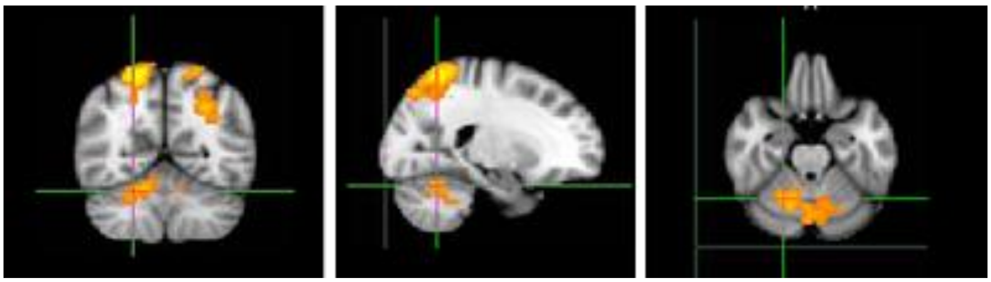


2.4B Big Picture Reappraisal >Rumination Postcentral Gyrus

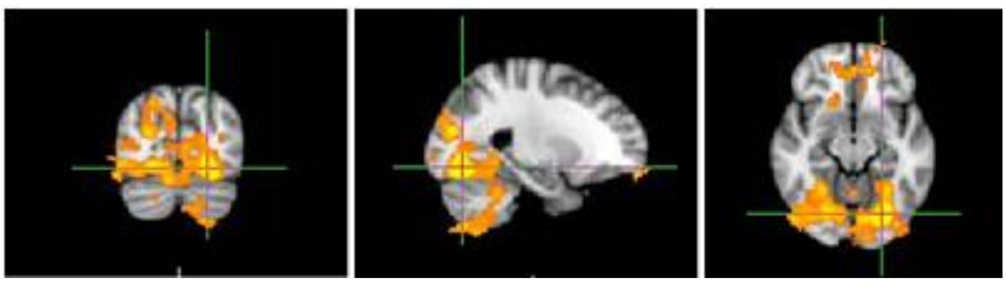


2.4C Big Picture Reappraisal >Rumination Superior Parietal

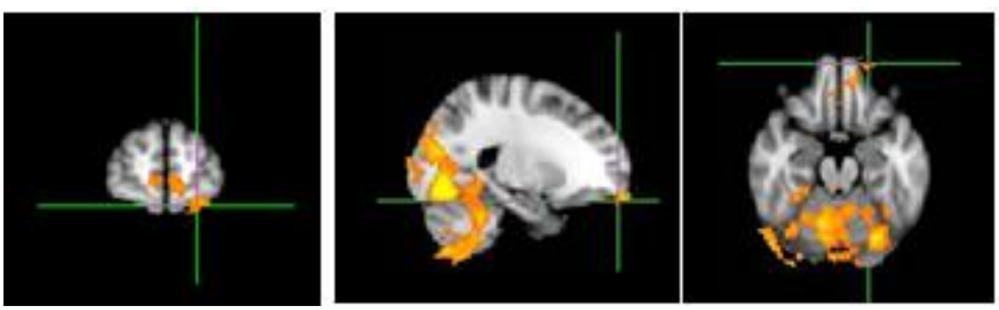
Figures 2.4A-2.4F (cont.)



2.4D Big Picture Reappraisal >Rumination Cerebellum Lobule VI



2.4E Big Picture Reappraisal >Distraction Occipital Fusiform Gyrus



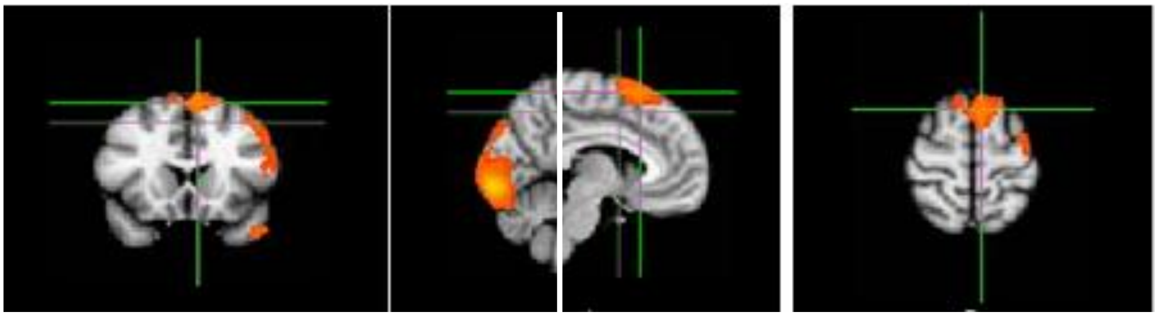
2.4F Big Picture Reappraisal >Distraction Frontal Pole

Table 2.2

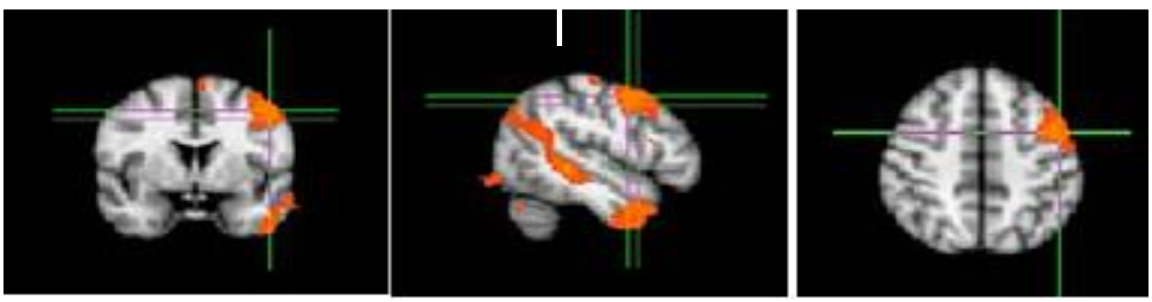
Cluster	X	Y	Z	Z/%	L/R	K	Cluster P
Big Picture Reappraisal>Rum							
Cluster 2.4A	**-18**	**-92**	**-8**	**5.27**	**L**	**1394**	**<0.05**
Occipital Pole				35%			
Occipital Fusiform Gyrus				13%			
Inferior Lateral Occipital Cortex				6%			
Lingual Gyrus				5%			
Cluster 2.4B	**-38**	**-36**	**+64**	**6.25**	**L**	**4407**	**<0.05**
Postcentral Gyrus				49%			
Superior Parietal Lobule				13%			
Cluster 2.4C	**+24**	**-54**	**+62**	**5.88**	**R**	**1336**	**<0.05**
Superior Parietal Lobule				45%			
Superior Lateral Occipital Cortex				12%			
Cluster 2.4D	**+22**	**-58**	**-24**	**4.09**	**R**	**1133**	**P<0.05**
Cerebellum Lobule VI				95%			
Cerebellum Lobule V				5%			
Big Picture Reappraisal>Distract							
Cluster 2.4E	**-24**	**-74**	**-12**	**8.82**	**L**	**16617**	**P<0.05**
Occipital Fusiform Gyrus				67%			
Lingual Gyrus				7%			
Inferior Lateral Occipital Cortex				1%			
Cluster 2.4F	**-22**	**+60**	**-20**	**4.50**	**L**	**1310**	**P<0.05**
Frontal Pole				16%			

Table 2.2 Group level BOLD results. Significant clusters surrounding peak MNI (x, y, z) coordinates are listed as well as cluster Z-values and percentage of brain regions associated with significant activation. All reported values reached cluster extent threshold FDR-corrected significance of $p<0.05$. K values correspond to spatial extent (i.e. number voxels) and L/R indicate laterality of findings.

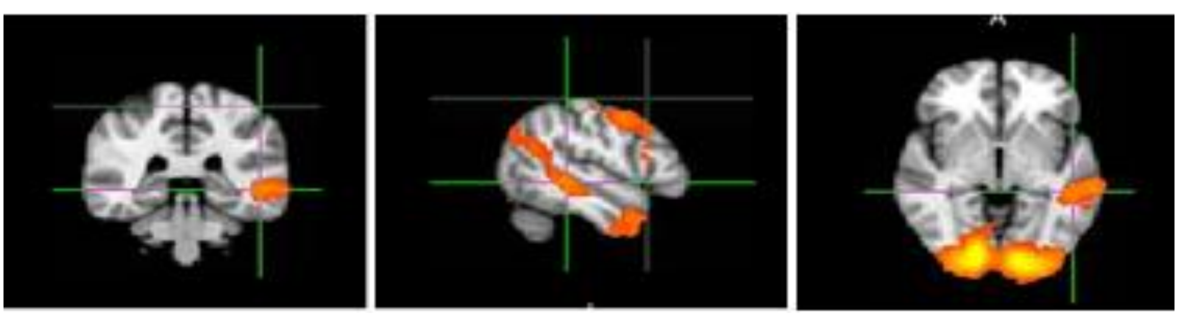
Figures 2.5A-2.5H. Brain regions showing significant (p<0.05, FDR corrected) BOLD signal in Condition contrasts. Big Picture Reappraisal > Visual Fixation, Rumination > Visual Fixation and Distraction > Visual Fixation in the coronal, sagittal, and transverse views; respectively.



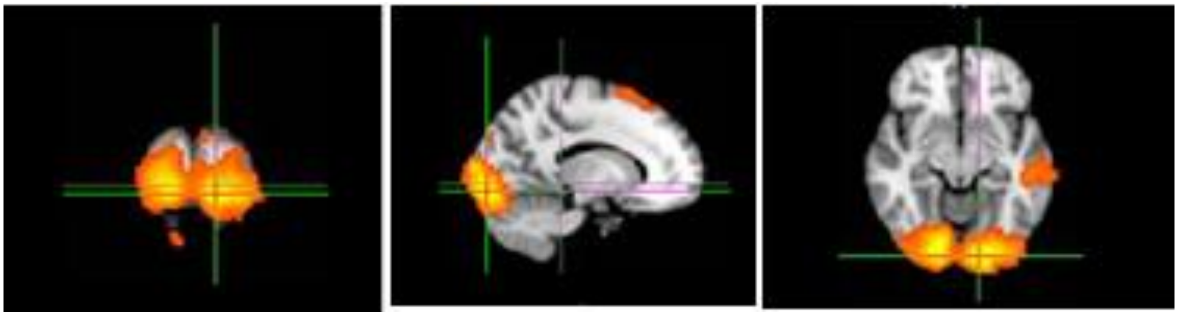
2.5A. Big Picture Reappraisal >Visual Fixation Superior Prefrontal.



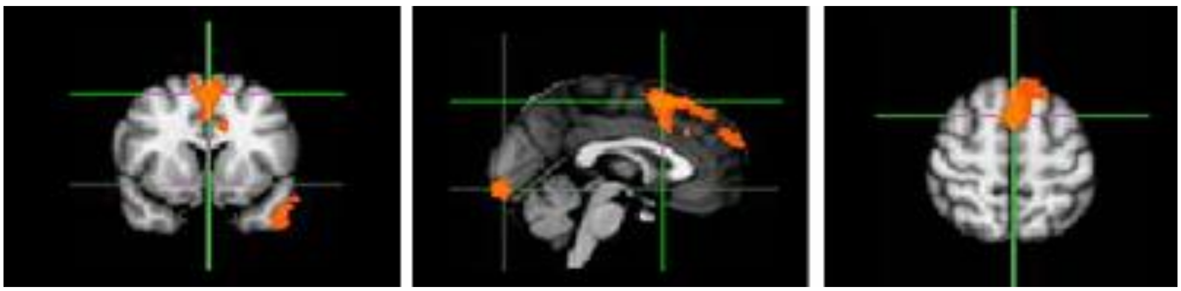
2.5B. Big Picture Reappraisal >Visual Fixation Precentral Gyrus.



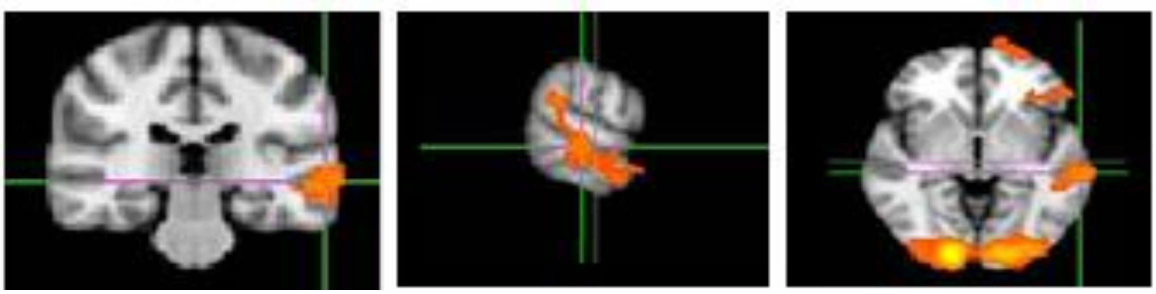
2.5C. Big Picture Reappraisal >Visual Fixation Middle Temporal Gyrus.



2.5D Big Picture Reappraisal > Visual Fixation Occipital Gyrus

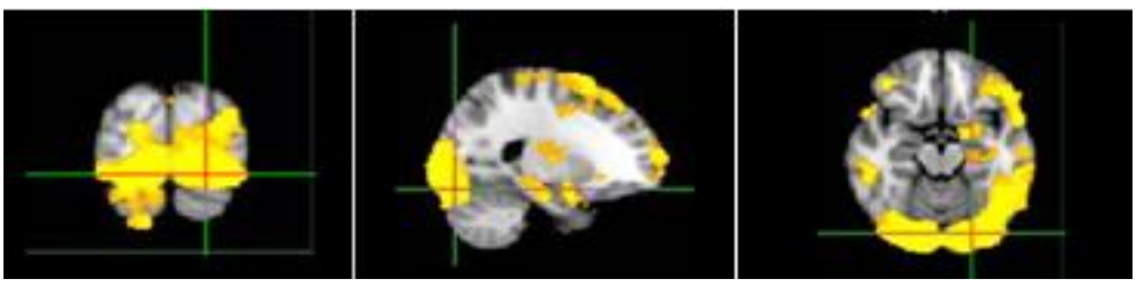


2.5E. Rumination > Visual Fixation Superior Prefrontal



2.5F. Rumination > Visual Fixation Middle Temporal

2.5G. Distraction > Visual Fixation Temporal Occipital Gyrus



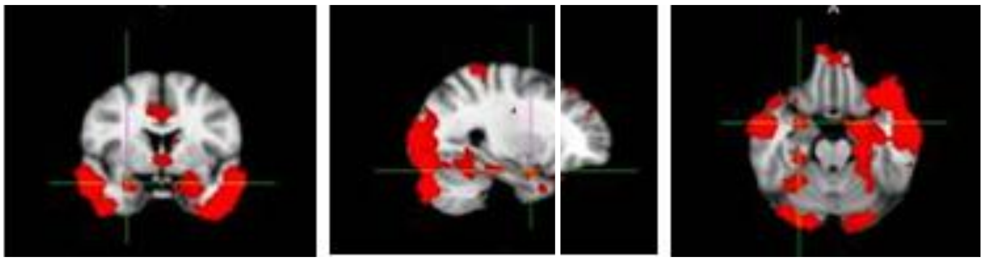
2.5H. Distraction > Visual Fixation Occipital Fusiform Gyrus

Table 2.3

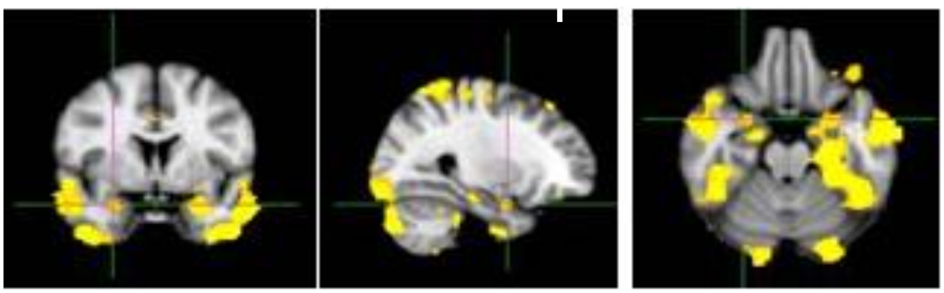
Cluster	X	Y	Z	Z/%	L/R	K	Cluster P
Big Picture Reappraisal>VF*							
Cluster 2.5A	**-6**	**+18**	**+62**	**5.64**	**L**	**929**	**<0.05**
Superior Prefrontal Gyrus				44%			
Cluster 2.5B	-48	+2	+48	5.61	L	1279	**<0.05**
Precentral Gyrus				52%			
Middle Prefrontal Gyrus				18%			
Cluster 2.5C	**-50**	**-36**	**-4**	**5.76**	**L**	**3073**	**<0.05**
Posterior Middle Temporal Gyrus				49%			
Posterior Superior Temporal Gyrus				13%			
Cluster 2.5D	**-14**	**-92**	**-10**	**12.8**	**L**	**12494**	**<0.05**
Occipital Pole				41%			
Occipital Fusiform Gyrus				13%			
Lingual Gyrus				9%			
Rumination>VF							
Cluster 2.5E	**0**	**+12**	**+56**	**5.12**	**L**	**3141**	**<0.05**
Superior Frontal Gyrus				23%			
Paracingulate Gyrus				11%			
Cluster 2.5F	**-62**	**-28**	**-4**	**5.06**	**L**	**2924**	**<0.05**
Posterior Middle Temporal Gyrus							
Posterior Superior Temporal Gyrus							
Distraction>VF							
Cluster 2.5G	**+64**	**-52**	**-8**	**4.70**	**R**	**1290**	**<0.05**
Middle Temporal Occipital Gyrus				66%			
Inferior Temporal Occipital Gyrus				14%			
Cluster 2.5H	**-22**	**-84**	**-16**	**11.48**	**L**	**53320**	**<0.05**
Occipital Fusiform Gyrus				55%			
Lingual Gyrus				6%			
Inferior Lateral Occipital Cortex				6%			

Table 2.3. Group level BOLD results. Significant clusters surrounding peak MNI (x, y, z) coordinates are listed as well as cluster Z-values and percentage of brain regions associated with significant activation. All reported values reached cluster extent threshold FDR-corrected significance of $p<0.05$. K values correspond to spatial extent (i.e. number voxels) and L/R indicate laterality of findings. *VF=visual fixation

Figures 2.6A-2.6B. Brain regions for hypotheses-relevant significance ($p<0.01$, uncorrected) BOLD signal for Rumination>Counting and Distraction>Counting in the coronal, sagittal, and transverse views; respectively. All activation values are listed in Table 2.4, only Clusters labeled 2.6A and 2.6B are pictured.



2.6A. Rumination>Counting, Amygdala Activation



2.6B. Distraction>Counting, Amygdala Activation

Table 2.4.

Cluster	X	Y	Z	Z/%	L/R	K	Uncorr P
Big Picture Reappraisal>Count							
Cluster	**+32**	**-88**	**-2**	**9.02**	**R**	**59523**	**<.05**
Inferior Lateral Occipital Cortex				44%			
Occipital Pole				15%			
Cluster	**+8**	**-52**	**-48**	**6.16**	**R**	**696**	**<.05**
Cerebellum Lobule IX				94%			
Cluster	**0**	**-14**	**+34**	**4.54**	**R**	**438**	**<.05**
Anterior Cingulate Gyrus				64%			
Posterior Cingulate Gyrus				34%			
Cluster	**-30**	**-24**	**+58**	**3.76**	**L**	**425**	**<.05**
Precentral Gyrus				32%			
Postcentral Gyrus				20%			
Cluster	**-16**	**-52**	**+70**	**3.23**	**L**	**71**	**<.05**
Superior Parietal Lobule				46%			
Postcentral Gyrus				14%			
Superior Lateral Occipital Cortex				8%			
Cluster	**-10**	**+14**	**+10**	**3.17**	**L**	**64**	**<.05**
Caudate				83%			
Rumination>Count							
Cluster	**-10**	**-48**	**30**	**9.13**	**L**	**48464**	**<.05**
Posterior Cingulate Gyrus				53%			
Precuneous Cortex				7%			
Cluster	**+56**	**-2**	**-20**	**6.69**	**R**	**3913**	**<.05**
Anterior Middle Temporal Gyrus				37%			
Anterior Superior Temporal Gyrus				16%			
Cluster	**+22**	**-38**	**+70**	**4.37**	**R**	**437**	**<.05**
Postcentral Gyrus				52%			
Superior Parietal Cortex				8%			
Cluster	**+6**	**-58**	**-48**	**5.44**	**R**	**141**	**<.05**
Cerebellum Lobule IX				**95%**			
Cerebellum Lobule VIIIb				5%			
Cluster	**+26**	**-32**	**-18**	**3.12**	**R**	**127**	**<.05**
Posterior Parahippocampal Gyrus				62%			
Posterior Temporal Fusiform				18%			
Cluster 2.6A	**+28**	**+2**	**-22**	**3.09**	**R**	**118**	**<.05**
Amygdala				**73%**			
Cerebral Cortex				**26%**			
Cluster	**-12**	**+4**	**+14**	**2.69**	**L**	**16**	**<.05**
Caudate				88%			
Distraction>Count							
Cluster	-56	-68	+22	6.66	L	21458	**<.05**
Superior Lateral Occipital Cortex				69%			
Inferior Lateral Occipital Cortex				3%			
Cluster	-8	+44	+50	6.35	L	8412	**<.05**
Frontal Pole				64%			
Superior Frontal Gyrus				15%			
Cluster	**+34**	**-6**	**-46**	**6.14**	**R**	**8208**	**<.05**

Table 2.4 (contt.)

Ant Temporal Fusiform Cortex				48%			
Post Temporal Fusiform Cortex				20%			
Ant Inferior Temporal Gyrus				14%			
Cluster	**+26**	**-84**	**-38**	**5.27**	**R**	**2037**	**<.05**
Cerebellum Crus II				100			
Cluster	**-54**	**+32**	**-4**	**4.65**	**L**	**1006**	**<.05**
Inferior Frontal Gyrus, pars triang				38%			
Frontal Pole				14%			
Orbital Frontal Cortex				7%			
Cluster	**+20**	**-52**	**+68**	**3.98**	**R**	**654**	**<.05**
Superior Parietal Lobule				54%			
Postcentral Gyrus				6%			
Cluster	**+46**	**-10**	**+56**	**3.34**	**R**	**215**	**<.05**
Precentral Gyrus				52%			
Postcentral Gyrus				13%			
Cluster	**+22**	**-48**	**-56**	**3.14**	**R**	**94**	**<.05**
Cerebellum Lobule VIIIb				95%			
Cerebellum Lobule VIIIa				5%			
Cluster	**+26**	**-24**	**-18**	**3.11**	**R**	**84**	**<.05**
Posterior Parahippocampal Gyrus				7%			
Anterior Parahippocampal Gyrus				4%			
Cluster	**+28**	**-34**	**-32**	**3.31**	**R**	**84**	**<.05**
Cerebellum Lobule V				73%			
Cerebellum Lobules I-IV				21%			
Cluster	**+18**	**-8**	**-20**	**3.31**	**R**	**79**	**<.05**
Hippocampus				65%			
Amygdala				31%			
Cluster	**+8**	**-62**	**-52**	**3.5**	**R**	**74**	**<.05**
Cerebellum Lobule IX				54%			
Cerebellum Lobule VIIIb				45%			
Cluster 2.6B	**+28**	**+2**	**-22**	**3.13**	**R**	**52**	**<.05**
Amygdala				73%			
Cerebral Cortex				26%			
Anterior Parahippocampal Gyrus				11%			

Table 2.4. Group level BOLD results. Significant clusters surrounding peak MNI (x, y, z) coordinates are listed as well as cluster Z-values and percentage of brain regions associated with significant activation. All reported values reached cluster extent threshold uncorrected significance of $p<0.01$. K values correspond to spatial extent (i.e. number voxels) and L/R indicate laterality of findings.

APPENDICES

Appendix A

Directed Perspective-Taking Prompts

Big Picture Statements

How this one moment fits into your whole life

How all your past feelings changed with time

How you have both good times and bad times

How important this will seem when you look back on it

How others have had similar things happen

The way you will view this several years from now

How your feelings are like those of others

How moods come and go

How every person experiences highs and lows

Distraction Statements

..a boat slowly crossing the Atlantic

…the layout of a typical classroom

..the shape of a large black umbrella

..movement of an electric fan on a warm day

..raindrops sliding down a windowpane

..a double decker bus driving down a street

..the expression on the face of the Mona Lisa

..two birds sitting on a tree branch

..the shadow of a stop sign

Rumination Statements

..what it would be like if your present feelings lasted.

..why things turn out the way they do.

..trying to understand your feelings.

..what people notice about your personality.

..how quick/slow your thinking is right now.

..trying to understand who you are.

..why you turned out this way.

..why you react the way you do.

..how hopeful/hopeless you are feeling.

Appendix B

Phone Screening Form for Potential Research Participants

Hi, my name is _____ from the UT Austin study about social rejection. Is this a good time for you to do the phone interview? Good, are you able to talk privately right now? (If NO, the interviewer will reschedule the telephone screening).

Patient's Rights:

Do you make your own medical decisions?

First, any information collected about you today will be kept completely confidential. If you are eligible for the study, the information collected in this screening would be used as data in the study. If you chose not to participate in the study, or do not meet the criteria for the study, all of your personal information will be destroyed. If you do participate, your personal information will be kept in a safe place and not shared with anyone outside of the study. These questions will help us determine your eligibility for this study, and most importantly, make sure that it is safe for you to participate. You do not have to answer anything that makes you uncomfortable. We respect your right to privacy. You are also free to ask as many questions as you wish to help you decide if you want to participate in this research. Do you understand? Is it okay with you to continue?

Date of Screen

General Information

Name:	DOB:	Ht:	Weight:
Sex:	Education:	Handedness:	
Phone:	Phone:	Email:	

Street Address: City: Zip:

Race/Ethnicity: Marital Status:

How did you hear about the study? :

Rejection Experience:

Have you had a recent rejection experience that still bothers you?

In a few words, describe your rejections experience:

How resolved do you feel about this situation?

Not Resolved Very Resolved

1----------2-----------3----------4----------5

About how often have you thought about this situation in the past week (before being asked this question)?

Not once 1-3 times 4-7 times 8-10 times 11-13 times 14-17 times 18 or more times

For the following items, 1= "not at all" and 7= "very much"

How emotional does this situation make you feel?

1-2-3-4-5-6-7

How sad?

1-2-3-4-5-6-7

How angry?

1-2-3-4-5-6-7

How hurt?

1-2-3-4-5-6-7

How rejected?

1-2-3-4-5-6-7

Please indicate what your relationship to this person was (e.g., romantic partner, friend, family member):

Psychiatric Background:

Have you ever been diagnosed with a psychiatric illness (e.g. depression, bipolar disorder, schizophrenia, obsessive-compulsive disorder, anxiety disorder)?

If yes, please explain.

Learning Disabilities:

Have you ever had a learning disability (e.g.dyslexia)

If yes, please explain.

Have you ever been diagnosed with ADHD or ADD?

Did you ever fail a grade or class?

If yes, please explain.

Did you receive special education or tutoring?

If yes, please explain.

As a child, did you have difficulties learning to read, write, or spell?

If yes, please explain.

As a child, did you have any problems speaking?

If yes, please explain.

As a child, did you have difficulty understanding speech?

If yes, please explain.

Medical and Neurological Problems:

Do you have any hearing problems? Explain

Do you have any problems with your vision? Explain

Have you ever had a seizure? Explain

Did you ever get hit in the head or 'knocked out'? Explain

Did you ever lose consciousness for any reason? Explain

If so, did you experience dizziness, blurred vision, or any other symptoms? Explain

Have you ever had surgery to the head (including ear surgery?) Explain

Do you have any breathing problems or motion disorder? Explain

Do you have a history of asthma, allergic reaction, respiratory disease, or a reaction to a contrast medium or dye used for an MRI, CT, or X-Ray examination? Explain

Do you have anemia or any disease that affects your blood, a history of renal (kidney) disease, renal failure, kidney transplant high blood pressure (hypertension), liver (hepatic) disease or seizures?

Explain

MRI Safety Information

Background Information & Medical History:

<u>Please indicate if you have any of the following:</u>

	Yes	No	D/K	Details
Any previous surgery (not above):				
History of head trauma				
Surgical aneurysm clips				
Cardiac pacemaker (even if removed)				
Implanted Cardioverter defibrillator (ICD)				
Electronic implant or device				
Magnetically activated implant/device				
Neurostimulator				
Spinal cord stimulator				
Internal electrodes or wires				
Bone growth/fusion stimulator				
Insulin or other infusion pump				
Implanted drug infusion device				
Any other types of prosthesis				
Prosthetic heart valve				
Eyelid spring or wire				
Artificial or prosthetic limb				

Metallic stent, filter, or coil

Shunt (spinal/intraventricular)

Vascular access port and/or catheter

Radiation seeds or implants

Swan-Ganz or thermodilution catheter

Transdermal patch (nicotine, nitroglycerin, hormone)

	Yes	No	D/K	Details
Wire mesh implant				
Tissue expander				
Surgical staples, clips, or metallic sutures				
Joint replacement (hip, knee , etc)				
Bone/joint pin, screw, nail, wire, plate, etc				
IUD, diaphragm, or pessary				
Cochlear or other ear implants				
Metal rods, plates, or screws				
Hearing aid				
Dentures, braces, or permanent retainer				
Injury to eye involving metal				

Injury by a metallic object to the body (BB, bullet, welding, etc)

Any other implants in the body

Do you typically experience claustrophobia? If yes, explain

Do you wear glasses or contact lenses? If contacts, are they colored?

Do you have any tattoos (including permanent eyeliner/make up anywhere in your body?

If yes, when and where did you get it?

Do you have any body piercings?

Have you ever worked as a welder or metal worker?

Have you ever had any major illnesses or other surgeries that we have not covered? Explain

Have you had a prior MRI imaging study?

If yes, specify Body part, Date, Facility

Have you experienced any problems related to a previous MRI exam?

Are you currently taking or have you recently taken any medication or drugs

If yes, explain

Are you allergic to any medication?

If yes, explain

Current information:

Do you drink alcoholic beverages? How many per week?

Was there ever a period of time when you drank more than 2 drinks per day on a regular basis?

If yes, when? How long did this last? How much per day?

Did you ever use recreational drugs? If yes, what?

Drugs/When used?

Marijuana Cocaine Methamphetamines LSD Heroin

Other

What current medications are you taking?

How much and how often do you take them?

Are you a tobacco user? If so, how much per day?

Do you consume caffeine? If so, how much per day?

Instructions for Day of Scan:

No caffeine or nicotine four hours before appointment

No mascara or hair gel in the scanner (due to trace amounts of metal)

No alcohol the night before scanning session

Closing:

Do you have any questions for me? Thank you very much for your time. If it seems like the study will be a good fit for you, I will call you to set up the appointment. Either way, I'll get back to you as soon as possible. Please feel free to email if you have any questions. Good-bye.

Appendix C

Social Rejection Description

Think about a situation in the past 6 months when the actions of another person led to feelings of rejection that still bother you.

In a few words, describe your rejections experience:

How resolved do you feel about this situation?

Not Resolved Very Resolved

1----------2-----------3----------4----------5

About how often have you thought about this situation in the past week (before being asked this question)?

Not once 1-3 times 4-7 times 8-10 times 11-13 times 14-17 times 18 or more times

For the following items, 1= “not at all” and 7= “very much”

How sad?

1-2-3-4-5-6-7

How angry?

1-2-3-4-5-6-7

How hurt?

1-2-3-4-5-6-7

Please indicate what your relationship to this person was (e.g., romantic partner, friend, family member):

REFERENCES

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review, 30*, 217-237.

Allen, G., Byerley, A. K., Lantrip, C., Lane, S., Ho, E., & Hsu, J. (2010). Functional neuroanatomy of the cerebellum. In A. S. Davis (Ed.), The Handbook of Pediatric Neuropsychology. New York, NY: Springer.

Anderson, M. C., Ochsner, K. N., Kuhl, B., Cooper, J., Robertson, E., Gabrieli, S. W., Glover, G. H., Gabrieli, J. D., (2004). Neural systems underlying the suppression of unwanted memories. *Science, 303*, 5655, 232-235.

Anderson, A.K., & Phelps, E.A. (2001). Lesions of the human amygdala impair enhanced perception of emotionally salient events. *Nature, 411*, 305-309.

Beck, A. T. (1976). Cognitive therapy and the emotional disorder. New York: International Universities Press.

Berkman, E. T., & Liberman, M. D. (2009). Using neuroscience to broaden emotion regulation: Theoretical and methodological considerations. *Social and Personality* Psychology Compass, 3, 1-19.

Conway, M., Csank, P., Holm, S., & Blake, C. (2000). On individual differences in rumination on sadness. *Journal of Personality Assessment, 75*, 404–425.

Cooney, R., Joormann, J., Eugene, F., Dennis, E., & Gotlib, I. (2010) Neural correlates of rumination in depression, *Cognitive, Affective, & Behavioral Neuroscience, 10(*4), 470-478.

Davis, R. & Nolen-Hoeksema, S. (2000). Cognitive inflexibility among ruminators and nonruminators. *Cognitive Therapy and Research, 24,* 699-711.

Denson, T., Pedersen, W., Ronquillo, J., & Nandy, A. (2009). The angry brain: neural correlates of anger, angry rumination, and aggressive personality. *Journal of Cognitive Neuroscience, 21,* 734-744.

Desmond, J., Gabrieli, J., Wagner, A., Ginier, B., & Glover, G. (1997). Lobular patterns of cerebellar activation in verbal working-memory and finger-tapping tasks as revealed by functional MRI. *The Journal of Neuroscience, 17*(24), 9675-9685.

Donaldson, C. & Lam, D. (2004). Rumination, mood and social problem-solving in major depression. *Psychological Medicine, 34*, 1309–1318.

Erdfelder, E., Faul, F., & Buchner, A. (1996). GPOWER: A general power analysis program. *Behavior Research Methods, Instruments, & Computers*, *28*, 1-11.

Forster, K. I., & Forster, J. C. (2003). DMDX: A windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, & Computers, 35,* 116-124.

Fossati, P., Hevenor, S., Graham, S., Grady, C., Keightley, M., & Craik, M. (2003). In search of the emotional self: A fMRI study with positive and negative emotional words. *American Journal of Psychiatry, 160,* 1938-1945.

Goldin, P., McRae., K., Ramel, W., & Gross, J. (2008). The neural bases of emotion regulation: reappraisal and suppression of negative emotion. *Biological Psychiatry, 63*, 577-586.

Gross, J. J. (1998). Antecedent- and response-focused emotion regulation: divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology, 74*(1), 224-237.

Gross, J. J. (2002). Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology, 39*, 281-291.

Gross, J. J. (Ed.) (2007). *Handbook of emotion regulation*. New York: Guilford Press.

Gross, J. (2001). Emotion Regulation in adulthood: Timing is everything. *Current Directions in Psychological Science,* 214-219.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*, 348–362.

Gross, J. J., & Thompson, R. A. (2007). Emotion regulation: Conceptual foundations. In J. J. Gross (Ed.), Handbook of emotion regulation New York: Guilford Press.

Gyurak, A., Goodkind, M. S., Madan, A., Kramer, J. H., Miller, B. L., & Levenson, R. W. (2009). Do tests of executive functioning predict ability to downregulate emotions spontaneously and when instructed to suppress? *Cognitive, Affective, & Behavioral Neuroscience, 9(*2), 144-152.

Hamann, S., Monarch, E., & Goldstein, F. (2000). Memory enhancement for emotional stimuli is impaired in early Alzheimer's disease. *Neuropsychology*, 14, 1, 82-92.

Hare, T. A., Camerer, C. F. & Rangel, A. (2009). Self-control in decision-making involves modulation of the vmPFC valuation system. *Science*, *324*, 646-648.

Hertel, P. & Gerstle, M. (2003). Depressive deficits in forgetting. *Psychological Science, 14*(6), 573-578.

Hertel, P. & Rude, S. (1991). Depressive deficits in memory: focusing attention improves subsequent recall. *Journal of Experimental Psychology, 120*(3), 301-309.

Hong, R. Y. (2007). Worry and rumination: Differential associations with anxious and depressive symptoms and coping behaviors. *Behavior Research and Therapy, 45*, 277-290.

Jackson, D., Malstadt, J., Larson, C., & Davidson, R. (2000). Suppression and enhancement of emotional responses to unpleasant pictures. *Psychophysiology*, *37*(4), 515-522.

John, O. P., & Gross, J. J. (2004). Healthy and unhealthy emotion regulation: Personality processes, individual differences, and life span development. *Journal of Personality, 72*, 1301-1333.

Johnson, S. C., Baxter, L. C., Wilder, L. S., Pipe, J. G., Heiserman, J. E., Prigatano, G. P. (2002). Neural correlates of self-reflection. *Brain, 125*, 1808–1814.

Johnson, M., Nolen-Hoeksema, S., Mitchell, K., & Levin, Y. (2009). Medial cortex activity, self-reflection and depression. Scan, 4, 313-327.

Johnson, M. K., Raye, C. L., Mitchell, K. J., Touryan, S. R., Greene, E. J., & Nolen-Hoeksema, S. (2006). Dissociating medial frontal and posterior cingulate activity during self-reflection. *Social Cognitive and Affective Neuroscience, 1*, 56-64.

Joorman, J., & Gotlib, I. H. (2010). Emotion regulation in depression: Relation to cognitive inhibition. *Cognition and Emotion*, *24*(2), 281-298.

Kim, S. & Hamann, S. (2007). Neural correlates of positive and negative emotion regulation. *Journal of Cognitive Neuroscience*, *19*(5), 776-798.

Koole, S. L. (2009). The psychology of emotion regulation: An integrative review. *Cognition and Emotion*, *23*, 1, 4-41.

Kross, E. & Ayduk, O. (2008). Facilitating adaptive emotional analysis: distinguishing distanced-analysis of depressive experiences from immersed-analysis and distraction. *Personality Social Psychology Bulletin, 34*, 924-938.

Kross, E., Davidson, M., Weber, J., & Ochsner, K. (2009). Coping with emotions past: the neural basis of regulating affect associated with negative autobiographical memories. *Biological Psychiatry*. *65*, 361-366.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping.* New York: Springer.

Levy, B. J. & Anderson, M. C. (2008). Individual differences in the suppression of unwanted memories: The executive deficit hypothesis. *Acta Psychologica, 127*(3), 623-635.

Martin, L. L., & Tesser, A. (1996). Some ruminative thoughts. In R.S. Wyer Jr. (Ed.), Ruminative thoughts (pp. 1–47). Mahwah, NJ: Erlbaum.

Miller, E. & Cohen, J. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience*, *24,* 167-202.

Mitchell, K. J., Raye, C. L., Ebner, N. C., Tubridy, S. M., Frankel, H., Johnson, M. K. (2009). Age-group differences in medial cortex activity associated with thinking about self-relevant agendas. *Psychology and Aging, 24*, 438–449.

Morrow, J. (1990). The effects of rumination, distraction, and negative mood on memories, evaluations, and problem solving. Unpublished manuscript, Stanford University, Stanford, CA.

Morrow, J., & Nolen-Hoeksema, S. (1990). Effects of responses to depression on the remediation of depressive affect. *Journal of Personality and Social Psychology, 58*, 519–527.

Nolen-Hoeksema, S. (1987). Sex differences in unipolar depression: Evidence and theory. *Psychological Bulletin, 101*, 259-282.

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. Journal of Abnormal Psychology, 100, 569−582.

Nolen-Hoeksema, S. (1996). Chewing the cud and other ruminations. *Ruminative thoughts.* Wyer, Robert S., Jr. (Ed.); pp. 135-144, Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Nolen-Hoeksema, S., & Morrow, J. (1991). A prospective study of depression and posttraumatic stress symptoms after a natural disaster: The 1989 Loma Prieta earthquake. *Journal of Personality and Social Psychology, 61*, 115-121

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science*, *3*, 400-424.

Ochsner, K. N., Bunge, S. A., Gross, J. J., & Gabrieli, J. D. (2002). Rethinking feelings: An fMRI study of the cognitive regulation of emotion. *Journal of Cognitive Neuroscience*, *14*, 1215-1299.

Ochsner, K. N., & Gross, J. J. (2008). Cognitive emotion regulation: Insights from social cognitive and affective neuroscience. *Current Directions in Psychological Science, 17*, 153-158.

Ochsner, K., Knierim, K., Ludlow, D., Hanelin, J., Ramachandran, T., Glover, G., & Mackey, S. (2004). Reflecting upon feelings: An fMRI study of neural systems supporting the attribution of emotion to self and other. *Journal of Cognitive Neuroscience*, *16*(10), 1746-1772.

Ochsner, K., Silvers, J., & Buhle, J. (2012). Functional imaging studies of emotion regulation: a synthetic review and evolving model of the cognitive control of emotion. *Annals of the New York Academy of Sciences. 1251*, E1-E24.

Phan, K., Fitzgerald, D., Nathan, P., Moore, G., Uhde, T., & Tancer, M. (2005). Neural substrates for voluntary suppression of negative affect: A functional magnetic resonance imaging study. *Biological Psychiatry, 57*(3), 210-219.

Philippot, P. & Brutoux, F. (2008). Induced rumination dampens executive processes in dysphoric young adults, *Journal of Behavior Therapy and Experimental Psychiatry, 39*, 219-227.

Raftery, J. & Bizer, G. (2009). Negative feedback and performance: The moderating effects of emotion regulation. *Personality and Individual Differences*, *47*(5), 481-486.

Ramachandran, V. (1995). Anosognosia in parietal lobe syndrome. *Consciousness and Cognition, 4,1*, 22-51.

Ray, R., Ochsner, K., Cooper, J., Robertson, E., Gabrieli, J., & Gross, J. (2005). Individual differences in trait rumination and the neural systems supporting cognitive reappraisal. *Cognitive, Affective, & Behavioral Neuroscience, 5*(2), 156-168.

Richards, J. & Gross, J. (2000). Emotion regulation and memory: The cognitive costs of keeping one's cool. *Journal of Personality and Social Psychology, 79*(3), 410-424.

Richardson, M., Stange, B., Duncan, J., & Dolan, R. (2003). Preserved verbal memory function in left medial temporal pathology involves reorganization to right medial temporal lobe. *NeuroImage. 20*, S112-S119.

Rude, S. (2011). *Thinking contextually about emotionally distressing events.* Unpublished manuscript, University of Texas, Austin, TX.

Rude, S., Mazzetti, F., Pal, H., & Stauble, S. (2011). Social rejection: How best to think about it? *Cognitive Therapy Research. 35*, 209-216.

Salkovskis, P. Psychological approaches to the understanding of obsessional problems. *In:* Obsessive-compulsive disorder: Theory, research, and treatment. Swinson, Richard P. (Ed.); Antony, Martin M. (Ed.); Rachman, S. (Ed.); Richter, Margaret A. (Ed.); New York, NY, US: Guilford Press, 1998. pp. 33-50.

Sharot, T., Riccardi, A. M., Raio, C. M., Phelps, E. A. (2007). Neural mechanisms mediating optimism bias. *Nature, 450*, 102-105.

Siegle, G., Steinhauer, S., Thase, M., Stenger, A., & Carter, C. Can't shake that feeling: Event-related fMRI assessment of sustained amygdala activity in response to emotion information in depressed individuals. *Biological Psychiatry, 51*(9), 693-707.

Stemmler, G. (1997). Selective activation of traits: Boundary conditions for the activation of anger. *Personality and Individual Differences*, *22*(2), 213-233.

Stoodley, C. & Schmahmann (2009). Functional topography in the human cerebellum: A meta-analysis of neuroimaging studies. *NeuroImage, 44*, 489-501.

Sutherland, K., & Bryant, R. (2007). Autobiographical memory in posttraumatic stress disorder before and after treatment. *Behaviour Research and Therapy, 45*(12), 2915-2923.

Thompson, R. A. (1991). Emotional regulation and emotional development. *Educational Psychology Review, 3,* 269-307.

Ward, A. H., Lyubomirsky, S., Sousa, L., & Nolen-Hoeksema, S. (2003). Can't quite commit: Rumination and uncertainty. *Personality and Social Psychology Bulletin*, *29,* 96-107.

Watkins, E. & Brown, R. G. (2002). Rumination and executive function in depression: An experimental study. *Journal of Neurosurgical Psychiatry*, *72,* 400-402.

Whitmer, A. J. & Banich, M. T. (2007). Inhibition versus switching deficits in different forms of rumination. *Psychological Science. 18*(6), 546-553.

Wilkowski, B. M., Robinson, M. D., Troop, W. (2010). How does cognitive control reduce anger and aggression? The role of conflict monitoring and forgiveness processes. *Journal of Personality and Social Psychology, 98*(5), 830-840.

VITA

Crystal Marie Lantrip was born and raised in China Spring, Texas and attended China Spring ISD from kindergarten through high school. She entered The University of Texas at Austin in 2003 and earned a Bachelor's of Science in Psychology, graduating cum laude in 2007. She worked as a research associate at the Imaging Research Center at The University of Texas at Austin after graduation. In August 2008, she entered The University of Texas at Austin once again in the counseling psychology doctoral program. She earned her Masters of Arts in Counseling Psychology in 2011. She is currently completing her predoctoral internship at Dartmouth Medical School, Neuropsychology Division.

Permanent Address: 1 Meadowbrook Village, Apt 21, West Lebanon, NH, 03784

This manuscript was typed by the author.